# NASA LANGLEY RESEARCH CENTER

# IMPLEMENTATION PLAN

**1998**

The illustration on the cover is symbolic of the work and commitment of the employees of Langley Research Center. Two-thirds of the illustration represents aeronautical research with the silhouette of an aircraft. One-third of the illustration depicts a night sky that represents space research. Approximately two-thirds of Langley's work is aeronautical research and one-third is space research. The large circle is symbolic of the earth and indicates our involvement with earth science. The seven stars are in memory of the seven astronauts lost during the Challenger accident.

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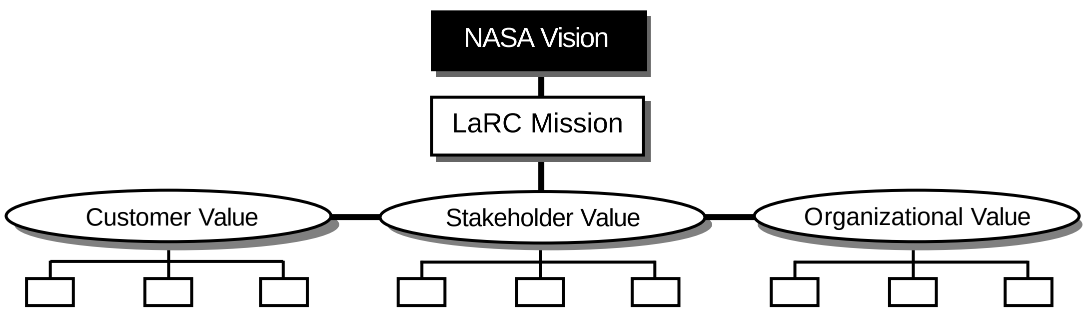
**http://larcip.larc.nasa.gov/**

# Strategic and Quality Framework and Implementation Plan of Langley Research Center

The Langley Strategic and Quality Framework (SQF) is designed to be an enduring, overarching guide for the overall management of the Center. It identifies three factors which are critical to Langley's success: providing value to our customers, informing our stakeholders of our value to the Nation, and increasing our productivity by striving to be a high performance organization.

The SQF reflects how the Center will operate more effectively and aligns with the NASA Strategic Plan, the National Performance Review, and the Government Performance and Results Act. The Implementation Plan describes what Langley is doing to support the goals and objectives described in the NASA Strategic Plan.

To focus the efforts of both managers and employees on the three critical success factors, nine strategic goals have been identified which encompass all types of work performed at the Center. Performance measures accompany the critical success factors and strategic goals as indicators of the success of our contribution to achieving the NASA vision.




## Customer Value

Customers value our partnership, use our products, and understand our role.

- Programs constitute a strategically balanced portfolio developed in partnership with customers.
- Investments and productivity are enhanced by partnerships with customers, educational institutions, and other government agencies.
- Technical programs are effectively accomplished to meet customer commitments.

## Stakeholder Value

Stakeholders' decisions reflect that LaRC returns good value on their investments.

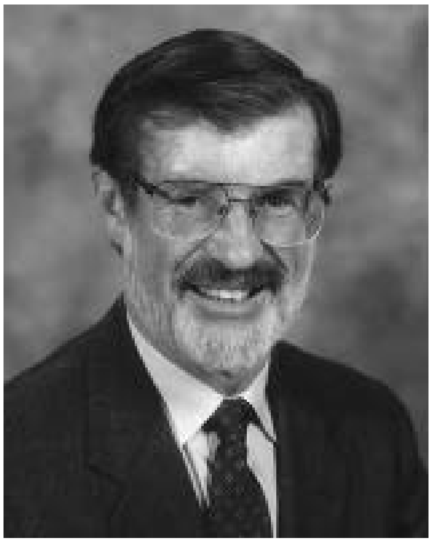
- Mission and programs are known to the public.
- Strategic partners support mission and programs.
- National decision makers support mission and programs.

## Organizational Value

Langley is an organization that learns, adapts, and improves to benefit employees, customers, and stakeholders.

- Increased value to customers and stakeholders is the key criterion for development, deployment, and recognition of employees.
- Labor/management partnership benefits LaRC.
- All processes efficiently deliver quality products and services.

# Director's Message



Langley Research Center celebrated its 80th Anniversary last year. Langley employees, past and present, are extremely proud of the contributions Langley has made to the Nation in the fields of both Aeronautics and Space over the last eight decades.

As we move toward the 21st Century, we are excited about the new opportunities and challenges set forth by the NASA Strategic Plan and the more specific goals of the four NASA Enterprise Plans.

Over the past 2 years Langley has developed the Strategic and Quality Framework (SQF) which explains **how** Langley will accomplish its mission in support of the NASA Strategic Plan and the Enterprises. The 1996/97 SQF booklet, distributed to all Langley employees, describes our focus on the three critical success factors noted on the opposite page. This Implementation Plan summarizes **what** commitments we have made in support of the NASA Programs.

The Implementation Plan defines the relationship of strategies from Enterprise Plans to the roles, missions, Center of Excellence, program-specific assignments, Lead Center responsibilities, and the Agency support activities of the Center. This document is the communications tool used to enable the Center's customers to see that their requirements are being addressed and to ensure that center employees understand their contributions to the highest level strategies and objectives of NASA.

The work we do aligns with the NASA Strategic Plan and sustains our core competencies. We are contributing to all four Enterprises and hold Agency leadership in several critical areas.

As we accomplish our goals, Center employees are urged to devote energies to the important things, to work efficiently, to do what we do with excellence, to finish what we start, and to have and project a positive attitude. With everyone at the Center focusing on his or her contribution to our critical success factors, we enhance our value to the Nation by carrying out our mission with the same standard of technical excellence that has traditionally characterized Langley.

Jeremiah F. Creedon
Director, Langley Research Center

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# Vision, Mission, and Values

The Langley Mission Statement is consistent with the Agency Mission Statement but delineates our unique role. It recognizes our focus on customers and our use of strategic alliances to enable us to do more and obtain more use of results. The Langley contribution to the NASA Vision is to be the world leader in pioneering science and innovative technology to ensure U.S. aeronautical and space preeminence.

## The NASA Vision

*NASA is an investment in America's future. As explorers, pioneers, and innovators, we boldly expand frontiers in air and space to inspire and serve America and to benefit the quality of life on Earth.*

## The Langley Mission

*In alliance with industry, other agencies, and academia, we develop airframe and synergistic spaceframe systems technologies to assure preeminence of the U.S. civil and military aeronautics and space industries; in alliance with the global research community, we pioneer the scientific understanding of the Earth's atmosphere to preserve the environment.*

## The Langley Values

***Integrity****—We are committed to maintaining the highest level of ethical conduct in fulfilling responsibilities to our customers, suppliers, and coworkers.*

***Technical Excellence****—Our products and services are recognized by customers, stakeholders, or peers to be of exceptional significance.*

***People****—A highly skilled diverse workforce is our most important resource. Every individual is valuable and deserves respect. We create an environment that fosters:*

- *Commitment*
- *Teamwork*
- *Innovation*
- *Continuous Improvement*
- *Trust*

***Flexibility****—We adapt and thrive in an environment of continual change, both as an organization and as individuals.*

# Missions and Roles of Langley Research Center

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Lead for Scientific and Technical Information

Lead for Program/Project Management Initiative Training

# Introduction

## Purpose

The purpose of the Langley Research Center (LaRC) Implementation Plan is to translate the NASA Strategic Plan and the Enterprise Strategic Plans into actions by summarizing the commitments of LaRC to the Enterprise Strategic Plans, Functional/Staff Office Plans, and other Government agencies. The Implementation Plan presents Langley's approach to implementation, as reflected in approved run-out budgets. Every Langley employee will see the relationship of his or her work to the NASA mission through the Implementation Plan. Langley customers will see that their requirements are addressed. The Implementation Plan will be updated annually as part of the strategic management process to reflect changes in the NASA Strategic Plan, the Enterprise Strategic Plans, and the Program Plans.

## Relationship to Strategic and Quality Framework

The intent of the Implementation Plan is to bridge the gap between the Enterprise Strategic Plans and the detailed Program Plans for specific areas within each Enterprise or Office. The Implementation Plan indicates what Langley is specifically committed to accomplish. The companion document, LaRC 1996-97 Strategic and Quality Framework, explains how the Center has focused the attention of all Langley employees on performing our work more effectively, and how we use our core competencies to fulfill our commitments and to provide value to both our customers and stakeholders. The combined documents accurately depict the **what** and **how** of the Langley approach to implementing its assigned goals and objectives.

## Missions and Roles

The major missions and roles assigned to the Langley Research Center are listed on page vii. Our primary mission assignments are Airframe Systems and Atmospheric Sciences. Langley is also designated the Agency Center of Excellence (COE) for Structures and Materials. A brief description of these and our other assignments follows.

### Primary Mission Assignments

***Airframe Systems*****—**The primary mission assignment for LaRC in support of the Aeronautics and Space Transportation Technology (ASTT) Enterprise is for Airframe Systems research. The Airframe Systems mission area is comprised of specific competency areas that, taken as a whole with those areas assigned to the other Code R centers, specify the primary dimensions of the Code R programs. These competency areas are used by Code R in selecting lead Centers for both Research and Technology Base activities and Systems Technology programs. LaRC core competency areas supporting the Airframe Systems mission are mission and systems analysis; aerodynamics, aerothermodynamics, and hypersonic airbreathing propulsion; structures and materials; and airborne system and crew station design and integration. The Center has a number of research facilities which support this mission area, and has been given the additional Agency responsibility (described later) for facility management oversight for wind tunnel, aerothermodynamic, and aeropropulsion facilities. In carrying out the Airframe Systems mission, LaRC interacts with external customers, other government organizations, universities, and other NASA Centers to ensure that planning, development, coordination, and program implementation result in successful accomplishment of the ASTT Enterprise goals and objectives.

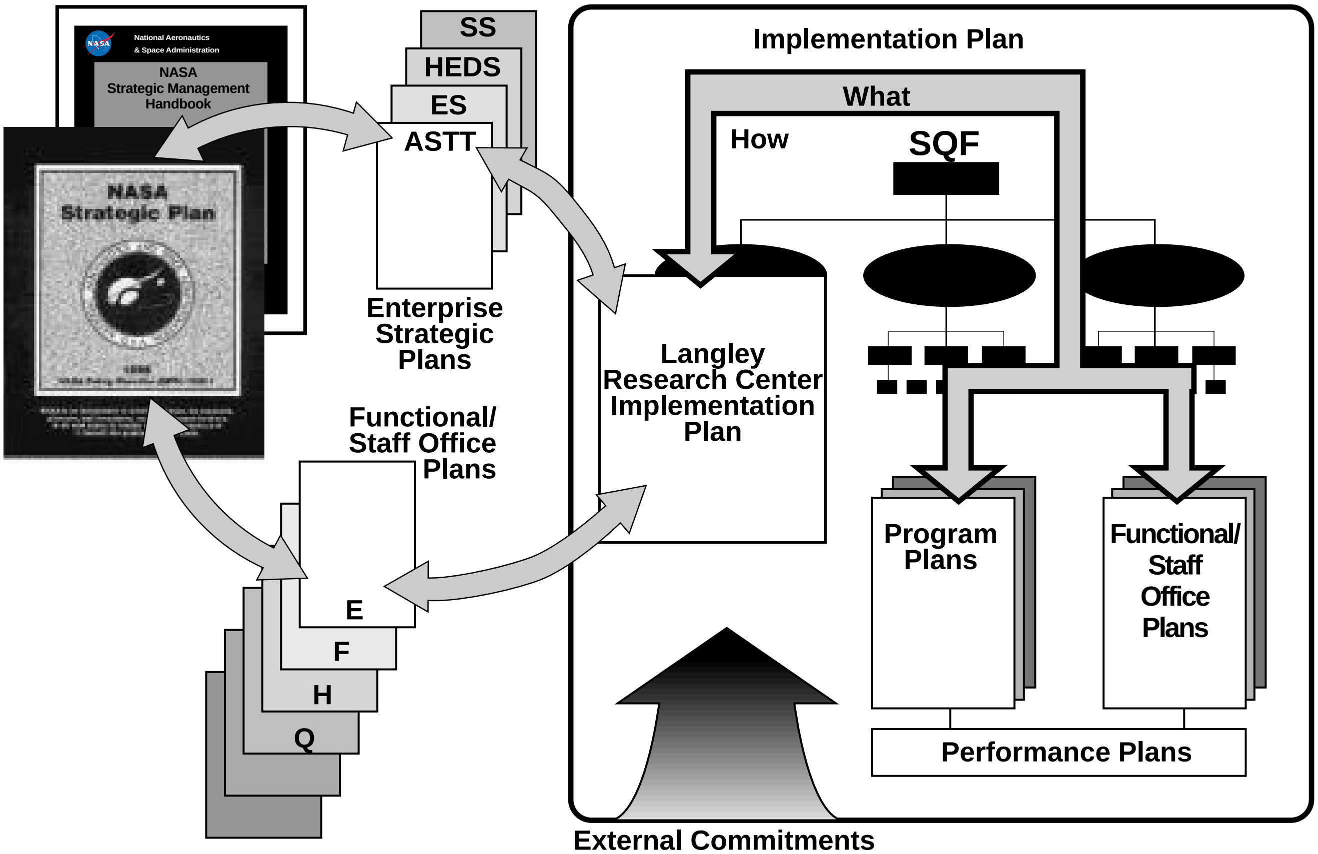


Figure 1. Relationship of Langley SQF and Implementation Plan to Agency management system.

***Atmospheric Sciences***—Langley has been given the mission responsibility for Atmospheric Sciences. The goal of the program is to meet the challenge of understanding the ever changing atmosphere of the Earth by collecting data and conducting research, which will help improve the knowledge of the current state of the atmosphere, as well as our understanding of human-induced and naturally occurring changes to the atmosphere. Langley will be working with other NASA Centers, other Government agencies, industry, and the academic community to better understand the processes that affect the structure and the make-up of the atmosphere. Some of these processes are radiation balance, chemical interactions, and dynamics (physical motions of the atmosphere). Current research is directed toward better measurements of some of these parameters from ground-based instruments and instruments on satellites, aircraft, and balloons and in the laboratory. These measurements are complemented by theoretical investigations that analyze atmospheric measurements with techniques such as statistics or computer modeling simulations.

### Center Of Excellence Assignment

***Structures and Materials***—Langley has been designated the NASA COE for Structures and Materials. Langley will provide the leadership for coordination, planning, advocacy, and assessment of the structures and materials research and technology development activities throughout the Agency. Langley will promote the development of new material systems and processes, innovative structural mechanics and dynamics design and analysis methods, and advanced structural concepts through technology validation for aircraft, space transportation vehicles, science instruments, and spacecraft. Langley will address technology challenges to enable more affordable, lighter weight, higher strength and stiffness, safer, and more durable vehicles for subsonic, supersonic, and sustained hypersonic flight; for Earth and other planetary atmospheric entry; and for spacecraft flight throughout the solar system.

Langley will be responsible for advocating the preservation and strengthening of the preeminent technical and programmatic expertise and ground test facilities and laboratories throughout the Agency. The COE will be led by Langley with strategic partnerships established among other Centers. Langley will coordinate with other COE's as appropriate to effectively and efficiently meet the research and technology needs of all Strategic Enterprises.

### Lead Program Assignments

***Advanced Subsonic Technology—***Langley has been designated as the lead Center for the management and implementation of the Agency's Advanced Subsonic Technology (AST) Program. The objective of the AST Program is to benefit the flying public by providing high payoff technologies for a safe global air transportation system, environmentally compatible aircraft, and reduced cost of air travel. Critical roles in the program are played by Ames Research Center (ARC), Lewis Research Center (LeRC) and Goddard Space Flight Center (GSFC). Program management works closely with the U.S. aeronautics industry and the Federal Aviation Administration (FAA), who have primary responsibility for application of candidate technologies, including operational demonstration and systems engineering.

***High Speed Research—***Langley has been designated as the lead Center for the management and implementation of the Agency's High Speed Research (HSR) Program. Langley coordinates development of critical technologies in aerodynamic performance, airframe materials and structures, flight deck technology, propulsion technologies (implementation at LeRC), and system integration elements. These elements include Technology Integration, Environmental Impact, TU-144 Experiments, and Atmospheric Effects of Stratospheric Aircraft (implementation at GSFC) that will enhance the economic viability and environmental compatibility of the High-Speed Civil Transport (HSCT). Langley maintains an ongoing relationship with airframe and propulsion industry partners, including Boeing, Pratt & Whitney, General Electric, and Honeywell, to ensure timely delivery of HSR technology, to ensure protection of the technology for our nation's civil aerospace industry, and to respond to changes in industry time lines and requirements.

***Airframe Systems Research and Technology—*** Langley has been designated as the lead Center for management and implementation of the Airframe Systems Research and Technology Base Program. The objective of the Airframe Systems Program is to pioneer the development of advanced technology concepts and methodologies, provide advanced tools and techniques, respond quickly to critical national issues, and provide the basis on which future focused programs are built. The Airframe Systems Program will pioneer the identification, development, verification, transfer, and application of high-payoff technologies. These technologies are aimed at providing benefits in one of six critical elements: advanced vehicle concepts, tools and test techniques, aviation safety, efficiency and affordability, high-performance aircraft, and cross-cutting applications. The program is conducted in cooperation with the U.S. industry, the Federal Aviation Administration, the Department of Defense, and the academic community.

***Aviation Safety—***Langley has been assigned lead responsibility for a national aviation safety initiative to develop the technology applications to enable an 80 percent reduction in the fatal accident rate by 2009 and a 90 percent reduction by 2018. The Office will work as a partner with the FAA in implementing the program and will closely coordinate with the Department of Defense (DoD) and other government agencies. Additionally, the Office will work with commercial, rotorcraft, and general aviation industry manufacturers, suppliers, and operators in implementing the program effort. Langley will also work in conjunction with Ames Research Center, Lewis Research Center, and Dryden Flight Research Center.

**Agency Functional Assignments**

***Independent Program Assessment—***Langley has been assigned the Agency lead role for conducting independent assessments of advanced concepts under consideration for advanced development and for the administration of reviews conducted in support of the Office of the Administrator and the Program Management Council (PMC). Responsibilities include supporting the Administrator regarding the approval of program development activities; conducting independent, multidisciplinary analyses and assessments of evolving aerospace systems designs moving from an advanced concept stage to that warranting consideration as a fully approved program; improving the quality of our program planning and verifying the feasibility of systems development and operational success; and scheduling, organizing, and conducting the PMC's Non-Advocate Reviews (NAR's), Independent Annual Reviews (IAR's) and Independent Assessments (IA's).

***Reusable Launch Vehicle System Analysis Support—***Langley provides program systems analyses, conceptual designs, and technology systems benefits for space access and hypersonic vehicles to NASA, DoD, and industry. For the reusable launch vehicle technology investment decision process, Langley provides the ASTT (Aeronautics and Space Transportation Technology) Enterprise with vehicle concept definition and analyses. Trade studies and performance analyses provide results that are used for selection of vehicle options and identification of design risk for vehicle development.

***Space Science Enterprise Implementation Support—***Langley provides expertise and support in science mission acquisition to the Office of Space Science (OSS), ensuring that the criteria for high quality science return within cost and schedule constraints are met. The primary responsibilities of Langley are in acquisition for Discovery and Explorer Program science missions. Langley oversees the development of assigned Announcements of Opportunity and NASA Research Announcements; manages the overall evaluation and selection process; conducts technical, management, cost, and other evaluations of proposals; and provides constructive feedback to the scientific community and their partners to enhance the quality of future proposals. Langley works with the OSS and its customers, which include academia, industry, NASA Centers and other Government agencies, to develop the most efficient and innovative methodologies that minimize proposal preparation and evaluation impacts.

***Wind Tunnel Facility Group—***Langley has been assigned the lead role for wind tunnel aerothermodynamic and aeropropulsion facility strategic management and will facilitate national alliances between NASA, DoD, U.S. industry, and possible foreign interests. The strategic management oversight includes creating common business and accounting policies and procedures for the many NASA wind tunnel facilities. Langley will develop and track common metrics and facilitate integrated wind tunnel scheduling for the primary facilities. LaRC will coordinate the development of plans for integrated wind tunnel requirements to meet internal and external needs and assess those requirements against existing capabilities. Based on the assessment, recommendations for facility upgrades and maintaining facility investment plans will be made. Langley will develop and advocate strategic facility-related research program and funding plans to ensure world class capability for the United States well into the future.

### Agency Support Activities

***Program Manager for Non-Destructive Evaluation—***Langley maintains Agencywide strategic goals, high level technical infrastructure, specific development objectives, and key activities for the Non-Destructive Evaluation (NDE) Program. Each Strategic Enterprise benefits from the NDE Program by the intrinsic technical and financial synergistic benefits of an Agencywide program focused on mission critical issues and enhanced safety, reliability, and mission success. The NDE Program provides an advisory and education forum that promotes Agencywide cooperation on mission critical issues, ensures the integrity of NDE processes, and educates the NASA community about the capability and applicability of NDE technologies. A NASA NDE Working Group (NNWG) was formed and has developed a Strategic Plan. The NNWG Strategic Plan is responsive to the budget, identifies what is needed to meet imposed requirements, and identifies the intercenter research and development activities necessary to evolve technologies and capabilities.

***Lead for Scientific and Technical Information—***LaRC has been assigned the lead Center responsibility for the Agency Scientific and Technical Information (STI) Program. This program will capture and disseminate NASA STI and provide access to worldwide mission-related information for its customers. When possible and economical, this information will be provided directly to the desktop in full-text information. This STI will include printed and electronic material, work-in-progress information, lessons-learned data, research laboratory files, wind tunnel data, metadata, and other information from the scientific and technical communities that will ensure the competitiveness of U.S. aerospace companies and educational institutions.

***Lead for Program/Project Management Initiative Training—***LaRC has been assigned the lead Center responsibility for the Program/Project Management Initiative (PPMI), an Agencywide resource established to provide total team and individual support for the benefit of developing and maintaining world class practitioners of project management in advance of need. PPMI is responsible for providing the necessary training and educational materials, as well as, supporting the professional development needs of people in project management. Due to major changes in NASA project management, PPMI will be responding to management requirements in a variety of ways. The major tasks that will represent the main thrust of PPMI products and services have been presented to, and supported by, the NASA Program Management Council Working Group (PMCWG).

## Functional and Staff Areas

To successfully accomplish its missions, Langley has in place an effective structure to carry out essential functional and support staff activities. These are described in Section VII of this Plan.

## Programs, Projects, and Activities

A comprehensive list of current and future programs, projects, and activities at Langley is provided in appendix A of this Plan.

## Contributions to the Strategic Enterprises

The LaRC program will concentrate primarily on the Aeronautics and Space Transportation Technology (ASTT) and the Earth Science (ES) Enterprises and will include synergistic efforts in Space Technology. LaRC activities in support of Human Exploration and Development of Space (HEDS) and Space Science (SS) will capitalize on the synergistic capabilities at the Center, will support primary programs in the other Enterprises and, where possible, will not significantly deplete the resources required for the ASTT and ES Enterprises efforts. Our core competencies, including specialized facilities, provide a unique national capability.

The LaRC ASTT program is a broad-based effort spanning the complete breadth of airframe systems.

Since the Langley role includes technology development for the entire aircraft, this approach positions LaRC as a vital national resource serving inherent government functions such as safety, national defense, the environment, and the national airspace system, and providing competitive technologies to U.S. industry.

The LaRC Atmospheric Sciences program is an Agency mission assignment that is conducted in collaboration with other Centers, other government agencies, and the international research community and will continue to focus on Earth radiation budget and atmospheric chemistry and dynamics.

Langley will develop Space Technologies in support of the Atmospheric Sciences program. We will develop spaceframe technologies that are synergistic with our airframe systems capabilities.

Our success will be measured by the extent to which our research results and technologies contribute to the design, development, and operation of future aerospace vehicles and missions and the extent to which our scientific research contributes to the understanding of human-induced climatic and environmental change. Langley will enhance the value of aerospace technologies by promoting technology transfer and commercialization by nonaerospace industries.

# Section I—Specific Roles in Support of Aeronautics and Space Transportation Technology Enterprise

The Aeronautics and Space Transportation Technology (ASTT) Enterprise has set bold objectives that are precompetitive research endeavors in long term, high risk, high payoff technologies that the private sector cannot afford to address due to the scale, risk, and duration of the tasks. These goals reflect national priorities for aeronautics and space as outlined by the National Science and Technology Council and in the National Space Policy. Langley plays a pivotal role in the three technology goals that are framed in terms of the anticipated benefit of technology developed by NASA that will be incorporated by industry in future aeronautics and space transportation systems. With a strong partnership among industry, government, and academia, our history of innovation and technological breakthroughs will continue as we enter the 21st century. The responsible Program Office or point of contact for each LaRC objective is indicated within the brackets.

## ASTT Technology Goal 1

***Global Civil Aviation***—Enable U.S. leadership in global civil aircraft through safer, cleaner, quieter, and more affordable air travel.

### Enabling Technology Objective 1—Safety

Reduce the aircraft accident rate by a factor of five within 10 years, and by a factor of ten within 20 years.

**LaRC Objectives**

- Develop and validate advanced technologies that reduce the aircraft accident rate from failure of aircraft controls, encounters with high intensity electromagnetic environments (EME), and failure of aging airframe structures [ASPO].
  - ❍ Develop and flight test an Intelligent Damage Adaptive Control System (IDACS) applicable to commercial transports.
  - ❍ Develop conceptual error-proof flight deck design to reduce the consequences of flight crew errors.
  - ❍ Determine feasibility of using formal methods to design and validate fail-safe, adaptive integrated aircraft flight control systems.
  - ❍ Develop system design and integration techniques to make aircraft systems immune to high intensity EME.
  - ❍ Develop accurate prediction methodologies and reliable non-destructive evaluation (NDE) techniques for evaluating the integrity of thick structural components in aging airframe structures.
  - ❍ Develop prototype corrosion detection methodology for mapping corrosion in hidden structures.
- Aging Aircraft—Develop advanced technology that may be used by U.S. airline operators and aircraft manufacturers to safely and economically extend the life of high time airplanes in the commercial jet transport fleet [AST].
  - ❍ Develop specialized engineering analysis tools to quantitatively evaluate inspection findings by computing remaining life, inspection intervals, and the residual strength of structural repairs.
  - ❍ Complete field demonstrations to illustrate technology utilization and conduct focused workshops to transfer all technology to the instrument manufacturing industrial community.

**Enabling Technology Objectives 2 and 3—Environmental Compatibility**

Reduce the emissions of future aircraft by a factor of three within 10 years and by a factor of five within 20 years.

Reduce the perceived noise levels of future aircraft by a factor of two from today's current subsonic aircraft noise levels within 10 years, and by a factor of four within 20 years.

### LaRC Objectives

- Exploit advanced smart systems concepts to improve drag, aeroelastic stability, and airframe noise [ASPO].
  - ❍ Develop technologies for smart aircraft systems to provide cost-effective improvements in boundary layer control for viscous drag reduction and thus reduced emissions.
  - ❍ Develop active component technologies that enable self-adaptive flight for revolutionary improvements through innovative smart material, devices, and systems that exploit dynamic and aeroelastic properties of airframe systems.
  - ❍ Develop breakthrough technologies in active structural controls to enhance aeroelastic stability of aircraft.
  - ❍ Apply revolutionary airframe systems technologies to reduce airframe noise.
- Environmental Assessment—Develop a scientific basis for assessment of the atmospheric impact of subsonic aviation, particularly commercial aircraft cruise emissions [AST/GSFC].
  - ❍ Collect available observational data pertinent to understanding long term changes (i.e., climatology) of NOx in lower atmosphere.
  - ❍ Complete tests of current technology engines.
  - ❍ Complete application of computer models in support of environmental assessment reports.
  - ❍ Conduct first field campaign with DC-8 Flying Laboratory for climate related measurements.
  - ❍ Complete first program-level assessment report, leading to participation by principal investigators (PI's) in preparation of 1998 United Nations Environment Programme/World Meteorological Organization (UNEP/WMO) ozone assessment report.
  - ❍ Conduct second DC-8 Flying Laboratory field campaign for ozone chemistry measurements.
  - ❍ Complete application of computer models in support of environmental assessment reports.
  - ❍ Complete second program-level assessment report, leading to participation by PI's in preparation of 2000 UNEP/WMO ozone and Intergovernmental Panel on Climate Change (IPCC) climate assessment reports.
  - ❍ Conduct third DC-8 Flying Laboratory field campaign for convective source measurements.
  - ❍ Complete application of computer models in support of environmental assessment reports.
  - ❍ Complete final program-level assessment report.
- Propulsion Emissions Reduction—Reduce the environmental impact of future engines by reducing NOx emissions [AST/LeRC].
- Noise Reduction—Provide technology to allow unrestrained market growth and compliance with international environmental requirements [LeRC/ARC].

- ❍ Develop first integrated fan noise source and propagation prediction code.
- ❍ Adaptive and active noise control duct treatment verified on low speed fan.
- ❍ Concepts validated for 3 dB jet noise for 1.5—6 bypass ratio engines and 3 dB fan noise reduction relative to 1992 technology.
- ❍ Concepts validated to improve nacelle duct treatment effectiveness by 25 percent relative to 1992 technology.
- ❍ Flight-applicable active noise control demonstration on large engine.
- ❍ Validate prediction and minimization methodology for community noise impact.
- ❍ Demonstrate 6 dB interior noise reduction relative to 1992 technology.
- ❍ Validate technology to reduce community noise impact by 10 dB relative to 1992 technology.

**<u>Enabling Technology Objectives 4 and 5—Affordable Air Travel</u>**

While maintaining safety, triple the aviation system throughput in all weather conditions, within 10 years.

Reduce the cost of air travel by 25 percent within 10 years, and by 50 percent within 20 years.

**LaRC Objectives**

- Develop, demonstrate, and validate advanced aeronautical concepts that lead to more affordable air travel through integrally stiffened fuselage structures, nonconventional aircraft designs, and advanced modeling and computational methods [ASPO].
  - ❍ Develop and demonstrate low-cost manufacturing processes and structural concepts for noncircular composite fuselage structures.
  - ❍ Develop and validate life prediction methodology for noncircular pressure structures.
  - ❍ Demonstrate feasibility of manufacturing integrally stiffened metallic fuselage components to provide for significant reductions in the manufacturing costs of aircraft fuselage components.
  - ❍ Develop preliminary durability and damage tolerance analysis methodology for integrally stiffened structure.
  - ❍ Verify cost reduction potential and durability and damage tolerance of integrally stiffened metallic fuselage subcomponents.
  - ❍ Develop and demonstrate reliability-based structural analysis and design methods to reduce vehicle design weight and cost.
  - ❍ Develop efficient, high fidelity multidisciplinary optimization methods to reduce time and cost for analysis and design of aero and aeroelastic properties of aerospace vehicles.
  - ❍ Develop advanced computational algorithms for the analysis of steady and unsteady viscous flows for high fidelity modeling of aircraft.
  - ❍ Develop and demonstrate improved test techniques to determine the aerodynamic characteristics of nonconventional configuration aircraft at high Reynolds number flight.
  - ❍ Develop a hierarchy of turbulence models for steady and unsteady Reynolds Averaged Navier Stokes (RANS) computations of complex flows to improve fundamental understanding of flow past aircraft.
- Airframe Materials and Structures—Provide validated fabrication methods and models for

economic, safe, and robust lightweight composite high-aspect-ratio wings and revolutionary airframes [AST].

- ❍ Award contract to airframe manufacturer.
- ❍ Baseline aircraft configuration selected and TAROC (Total Aircraft Related Operating Costs) goals defined.
- ❍ Preliminary design and requirements documentation (loads, growth potential, systems interfaces, damage scenarios, repair/maintenance, weight and cost targets).
- ❍ Develop manufacturing plan (cost budget allocations and structural development plan.
- ❍ Manufacturing equipment operational, fabrication and assembly processes defined and cost budgets revised.
- ❍ Verify, by critical design review, semispan wing and side of body joint meet all strength, maintenance, and cost requirements to ensure the potential wing cost by 20 percent and airline direct operating cost by at least 4 percent.
- ❍ Assemble the semispan wing, conduct Test Readiness Review, and compare costs to reduce cost of air travel goal requirements.
- ❍ Verify robustness of the fabrication process and compare costs with wing acquisition cost goal requirements through construction of 10 replicas of the semispan lower wing cover.
- ❍ Define advanced low-cost (nonautoclave, toolless) fabrication concepts that offer potential for up to 40 percent acquisition cost savings and associated reductions in airline direct operating cost.
- ❍ Verify, through semispan wing tests, that all load requirements are met and analytical methods reliably predict strength and stiffness.
- ❍ Assemble the semispan wing and side of body joint structural test article, conduct Test Readiness Review, and compare costs with wing acquisition cost goal requirements.
- ❍ Provide for higher fidelity designs at reduced cost and time through theoretical process models for the advanced fabrication concepts.
- ❍ Verify that cost targets meet the reduced cost of air travel goal requirements through semispan wing and side of body article loads tests, and that analytical methods reliably predict strength and stiffness.
- ❍ Verify process models and advanced fabrication concepts on scaled primary structure components.

- Airframe Methods—Enhance the competitive position of the U.S. transport aircraft industry by delivering integrated design methodologies, new aerodynamic concepts, and faster design cycles. These concepts and tools will provide superior aircraft and improved market responsiveness while reducing operating and ownership costs, environmental impacts, and aircraft development risks [AST].
  - ❍ Establish baseline configuration, total aircraft related operating costs (TAROC) and design cycle time reduction objectives relative to the baseline, and element requirements to meet objectives.
  - ❍ Swept-wing suction panel design criteria established.
  - ❍ Midterm assessment of impact of Integrated Wing Design (IWD) element deliverables on TAROC and design cycle time compared to the baseline configuration.

- ❍ Demonstrate 0.2 percent reduction in TAROC from wing design tools.
- ❍ Propulsion system/high lift system integration test will yield a 0.5 percent reduction in TAROC.
- ❍ Demonstrate 0.4 percent reduction in TAROC from wing/propulsion integration design tools.
- ❍ Establish a minimum of 10 percent reduction in aeronautical design cycle time from pressure sensitive paint application to aero and structural assessments.
- ❍ Reduce TAROC by additional 0.5 percent through advances in high-lift design methodology.
- ❍ Demonstrate an additional 0.5 percent TAROC reduction through final validation tests of advanced wing and propulsion integration tools.
- ❍ Demonstrate a reduction in aeronautical design cycle time of 50 percent through integrated numerical and experimental capability.
- ❍ Industry assessment of impact of final deliverables on TAROC and design cycle time compared to the baseline configuration.

- Engine Systems—Improve cost competitiveness by reducing engine design cycle time, and improve engine durability [AST/LeRC].
- Systems Evaluation—Provide credible assessments of the impact of alternative emerging civil aeronautics technologies on the integrated aviation system [AST].
  - ❍ Release second generation aviation system analysis capability.
  - ❍ Release final aviation system analysis capability.
  - ❍ Upgrade and perform final validation of aviation system analysis capability.

- ❍ Terminal Area Productivity (TAP)—Develop technologies and procedures enabling operation of the airport terminal area in instrument-weather, or nonvisual, conditions to safely match that of clear weather or visual conditions [ARC and TAP-AST].
- ❍ Reduce landing approach spacing requirements with the aid of new sensors and procedures to detect and avoid wake vortex hazards of preceding aircraft.
- ❍ Develop technologies to improve flight crew and ground controller situation awareness of airborne traffic to enable reduced separation standards for closely spaced parallel runway operations.
- ❍ Develop and assess methods to integrate the ground based Center-TRACON Automation System (CTAS) with the airborne Flight Management Systems (FMS) of modern transports to improve operational efficiencies in the airport terminal area.
- ❍ Develop technologies and methods to improve the situation awareness of flight crew and ground controllers during low visibility landing and surface operations.
- ❍ Complete field demonstrations, including flight tests, to validate new concepts for terminal area capacity improvements and to promote the transfer of this technology into operational usage.

- Advanced Air Transportation Technologies (AATT)—Develop technologies that will enable users of National Airspace System to operate with increased efficiency and to realize flexibility benefits possible under a future free-flight environment [ARC AATT-AST].
  - ❍ Assess airborne flight system requirements for efficient operations in a free-flight environment.

- ❍ Develop, evaluate, and demonstrate the feasibility of airborne traffic avoidance concepts to aid in determining the appropriate mix of ground-based and airborne-based traffic management responsibilities.

- Short-Haul/Civil Tilt Rotor (CTR)—Develop low-noise tilt rotor technology and flight procedures enabling community acceptance of civil tilt rotor aircraft through achievement of the FAA recommended criterion of 65 day-night sound level or less outside the area owned or controlled by the vertiport [ARC CTR-AST].
  - ❍ Identify, analyze, and experimentally assess low-noise tilt rotor concepts.
  - ❍ Develop and validate tilt rotor noise prediction and noise impact modeling methodologies.
  - ❍ Develop and assess terminal area operational procedures for tilt rotors that minimize noise impact on the ground.
- Validate enhanced vision sensor technology to allow aircraft to land and take off in low visibility weather conditions [DARPA-RTG].
  - ❍ Develop electromagnetic characterization of materials for new aircraft radome designs to operate at millimeter wave and X-band weather radar frequencies.
  - ❍ Perform flight demonstration tests of a Passive Millimeter Wave Camera through a cooperative agreement with a DARPA TRP industry and government consortium to demonstrate the ability to see through weather.
- Evaluate applicability of enhanced vision sensor technology for low visibility surface operations during rollout and taxi flight segment, runway intrusion flight taxi situation, and Controlled Flight into Terrain (CFIT) [DARPA-RTG].
- Evaluate runway surface radiometric image enhancement techniques for low visibility flight conditions [DARPA-RTG].

## ASTT Technology Goal 2

***Revolutionary Technology Leaps***— Revolutionize air travel and the way in which aircraft are designed, built, and operated.

### <u>Enabling Technology Objective 6—High Speed Travel</u>

Reduce the travel time to the Far East and Europe by 50 percent within 20 years, and do so at current subsonic ticket price.

### LaRC Objectives

Establish the technology foundation to support the U.S. transport industry's decision for production of an environmentally acceptable, economically viable, 300 passenger, 5,000 n.mi. range, Mach 2.4 aircraft [HSR].

- Aerodynamics and Flight Control—Complete studies by 2000 to support the development of an advanced supersonic cruise airplane with 33 percent more range and capable, with expected low-noise engine nozzles, of a 50 percent reduction in take-off noise footprint [HSR].
  - ❍ Develop and experimentally validate advanced high-lift systems and the related design methods to provide improved take-off and landing performance and low community noise.
  - ❍ Develop and experimentally validate advanced, low-drag supersonic and transonic cruise airplane concepts and the related design methods to provide substantial increases in cruise efficiency.
  - ❍ Develop and validate the integrated flight and propulsion control system concept and design methods required for an efficient, certifiable, and safe commercial high speed transport.

- Materials and Structures—Develop wing and fuselage structural designs by 2002 that are 33 percent lighter than can be achieved using Concorde technology and have the durability to survive flight temperatures up to 350° F for 60,000 hours [HSR].
  - Develop durable advanced titanium materials and high-temperature polymer matrix composites, adhesives, and sealants, and associated cost-effective processing, fabrication, and joining methods.
  - Develop accelerated test methods for validating the long term high-temperature durability of advanced metallic and composite materials, adhesives, and sealants.
  - Develop lightweight structural concepts and validated methods for analyzing advanced wing and fuselage structures under combined thermal, mechanical, and pressure loads.
  - Verify fabrication and structural testing techniques for a large-scale wing and fuselage structures.
- Flight Deck—Develop the necessary advanced systems and certification guidelines by 2001 for safe and efficient aircraft operations in the international airspace system [HSR].
  - Develop external visibility system sensors and displays permitting take-off and landing without a drooped nose and permitting all-weather operations.
  - Develop flight guidance and control for precision flight-path management and handling qualities within the air traffic control environment.
  - Verify advanced cockpit concepts incorporating synthetic vision, high-level information management, and integrated displays and controls.
- Technology Integration—Merge the HSR technology developments into a complete vehicle system evaluation to measure the progress of technology development to support technology select decisions [HSR].
  - Evaluate the baseline technology airplane annually through trade studies that are conducted to continually refine the baseline concept and assess alternates as technological progress is made.
  - Integrate the key elements for technology synergy and develop a multidisciplinary design process to deliver the Level II Optimized Aeroelastic Concept milestone in fiscal year 1998 while supporting the Level I Technology Configuration in fiscal year 1999.
- Environmental Impact—Extend and complete the efforts to define the critical HSCT environmental compatibility requirements in the areas of atmospheric effects, community noise, sonic boom impact, and atmospheric ionizing radiation to establish a technology foundation by 2002 to meet these requirements [HSR].
  - Conduct an annual assessment to evaluate the ability and robustness of the baseline configuration to achieve compatibility with the environment.
  - Include in the annual report an update of the status of international regulations that could impact the airplane.
- Tu-144—Validate critical engineering prediction capabilities and learn about supersonic transport design practices and operational characteristics by 1998 [HSR/ DFRC].
  - Measure structure and cabin noise to evaluate damping techniques for passenger comfort.

- Atmospheric Effects of Stratospheric Aircraft—Extend and complete the efforts to assess the potential atmospheric impact of a fleet of HSCT aircraft and to allow a confident decision regarding further aircraft technology development by 1998 [HSR and DRFC].
- Enabling Propulsion Materials—Provide materials by 2002 for the propulsion system that will meet the low emissions and low noise environmental requirements, while meeting the weight, performance, and durability requirements [HSR/LeRC].
- Critical Propulsion Components—Develop the component technologies by 2002 for an advanced HSCT propulsion system which would be both environmentally compatible and economically viable (i.e., low nitrogen oxide emissions, low-noise, high performance, and low specific fuel consumption) [HSR and LeRC].

**LaRC Longer Term Objectives**

- Prepare technology risk reduction beyond HSR Phase II emphasizing full scale engine/nozzle demonstration tests [HSR and LeRC] and airframe materials and structures for viable low-cost manufacturing processes [HSR].

**<u>Enabling Technology Objective 7—General Aviation Revitalization</u>**

Invigorate the general aviation industry, delivering 10,000 aircraft annually within 10 years, and 20,000 annually within 20 years.

**LaRC Objectives**

- General Aviation—Support revitalization of U.S. general aviation by developing and transferring technology to enhance small aircraft transportation system capabilities [AST].
    - ❍ Select system components for evaluation.
    - ❍ Complete assessments of current and latent market and assess domestic and international benefits.
    - ❍ Evaluate and select prototype systems for integrated testing.
    - ❍ Simulation and flight test validated transportation system concepts.
    - ❍ Publish design guidelines, system standards, and certification bases and methods.

**<u>Enabling Technology Objective 8—Next-Generation Design Tools and Experimental Aircraft</u>**

Provide next-generation design tools and experimental aircraft to increase design confidence, and cut the design cycle time for aircraft in half.

**LaRC Objectives**

- Develop and demonstrate advanced tools and techniques that overcome barrier technology issues on a broad range of airframe systems [ASPO].
    - ❍ Develop and demonstrate active vertical tail buffet alleviation system to alleviate impact of forebody generated vortices on fatigue life of vertical tail structure.
    - ❍ Develop Active Aeroelastic Wing (AAW) concept for flight validation to improve long range cruise performance of aircraft.
    - ❍ Develop and demonstrate advanced control law design methodology for multi-element integrated controls applications that will increase aircraft agility for all mission phases.
    - ❍ Provide technologies that allow pilots to recover from out of control "falling-leaf" motion, reducing aircraft incidents and losses and improving fleet operational effectiveness.

- ❍ Provide nonlinear computational fluid dynamics technology that allows rapid analysis during the aircraft conceptual and preliminary design phase.
- ❍ Develop and validate analysis and prediction methods for control of highly unstable airframes.
- ❍ Develop advanced concepts for uninhabited combat air vehicles and compare agility characteristics with conventional, inhabited aircraft.
- ❍ Fabricate and test models to validate aerodynamic and aeroelastic characteristics of uninhabited combat air vehicles.
- ❍ Develop technologies that improve aircraft survivability for a wide range of missions without degrading performance.
- ❍ Support development of new air vehicles by DoD and industry and assist in solving technical problems with existing aircraft.
- ❍ Complete drop test of an F-18 model to support F-18E/F engineering and manufacturing development.
- ❍ Coordinate NASA support for the development of the Joint Strike Fighter (JSF).
- ❍ Conduct systems studies to identify high potential aeronautical systems and concepts and high payoff technologies.
- ❍ Complete development of a national level macrobenefit model, and review Office of Aeronautics and Space Transportation Technology programs to assess projected program goals.
- ❍ Develop cycle and flow path models that represent state of the art and advanced technology subsonic engines.
- ❍ Develop higher order nozzle performance prediction code.
- ❍ Establish peer reviewed university grants to foster the development of high payoff, high leverage airframe systems technologies.

- Develop and demonstrate, with ground and flight tests from Mach 5 to Mach 10, the methods and tools for conceptual design and performance predictions of hypersonic aircraft with an airframe-integrated dual-mode scramjet propulsion systems [ATTO].

## ASTT Technology Goal 3

***Access to Space*—**Enable the full commercial potential of space and expansion of space research and exploration.

### <u>Enabling Technology Objective 9—Revolutionizing America's Space Launch Capabilities</u>

Reduce the payload cost of low Earth orbit by an order of magnitude, from $10,000 per pound to $1,000 per pound within 10 years.

**LaRC Objectives**

- Develop and demonstrate technologies for the X-33 and X-34 in aerothermodynamics, structures, materials, and vehicle systems, in support of industry partners for successful flight testing in 1999 and for the validation of RLV technologies [MSFC-RLV].
  - ❍ Support X-33 and X-34 flight system development and flight test planning. Assist in post flight test results analysis to validate analytical tools and technologies in support of the operational RLV and future launch vehicle developments [MSFC-RLV].
  - ❍ Provide the aerodynamic and aerothermodynamic analyses and develop the detailed databases required for development of advanced space transportation systems [ATTO].

- ❍ Support vehicle configuration design and maturation of the "Venture Star" operational RLV to meet mission operational and flight design requirements. [ATTO].
- ❍ Develop structures and materials for RLV's, including composite materials for primary structures and cryotanks, durable and operable metallic thermal protection systems, and refractory composite materials [ATTO].
- ❍ Develop and assess space access vehicle concepts, identifying systems sensitivities, operational characteristics, and technology requirements and benefits for future investment decisions [ATTO].

**Enabling Technology Objective 10—Revolutionizing America's Space Launch Capabilities**

Reduce the payload cost to low Earth orbit by an additional order of magnitude, from thousands to hundreds of dollars per pound by the year 2020.

**LaRC Objectives**

- Develop and assess advanced space access vehicle concepts which meet projected mission, operational, and affordability requirements by identifying systems sensitivities, technology requirements, and benefits to support future investment decisions [ATTO].
- Demonstrate and validate the technology and the experimental and computational methods and tools for design and performance predictions for an airframe-integrated scramjet-powered Mach 10 configuration (Hyper-X) by 2001 [ATTO].
  - ❍ Conduct test of Hyper-X vehicle in the 8-ft. High Temperature Tunnel.
  - ❍ Flight test dual-mode scramjet-powered Hyper-X vehicle over Mach 5-10 speed range.
  - ❍ Correlate flight test results with experimental and computational results.
- Develop experimental databases and conceptual designs of combined air-breathing and rocket propulsion systems. Expand test and analysis capabilities to support propulsion flow path and vehicle configuration studies [ATTO].
- Develop structures and materials for reusable launch vehicles, including composite material for primary structures and cryotanks, durable and operable metallic thermal protection systems, and refractory composite materials [ATTO].
- Support the configuration development of advanced space transportation systems through both experimental and analytical aeronautical and aerothermodynamic studies [ATTO].
- Exploit the synergy of aeronautics technology programs in advanced lightweight, high-temperature metallic and composite materials (Goal 6), structural concepts and analysis (Goals 4 and 5), low-cost manufacturing (Goals 4 and 5), and computational fluid dynamics (Goal 8) [ATTO].

## ASTT Service Goal

***Research and Development (R&D) Services—*** Enable, and as appropriate, provide on a national basis, world-class aerospace R&D services, including facilities and expertise, and proactively transfer cutting-edge technologies in support of industry and U.S. Government R&D.

**LaRC Objective**

- Develop implementation strategies for continued access by industry and other government agencies to Langley R&D services, facilities, and expertise in discussions with the ASTT Enterprise.
- Carry out Langley's Agency strategic management oversight responsibility for wind tunnels, aerothermodynamic, and

aeropropulsion facilities. These responsibilities are discussed more fully in the Mission and Roles section under Wind Tunnel Facilities Office. The points of contact are found at the end of this document.

- Oversight of the Langley aerospace technology transfer process is conducted by the Program Offices. These offices are discussed in the Mission and Roles section. The points of contact are found at the end of this document.

- Oversight of Langley nonaerospace technology transfer process is discussed in Section VII, LaRC Functional and Staff Areas. The points of contact are found at the end of this document.

# Section II—Specific Roles in Support of Earth Science Enterprise

The Earth Science (ES) Strategic Plan provides for an understanding of the total Earth system and the effects of natural and human-induced changes on the global environment from space-based and in situ capabilities that will yield new scientific information that is of practical use to national decision makers. Langley plays an important role in the ES program by providing key atmospheric science information and contributing to the Enterprise Goals in significant ways.

## ES Enterprise Goal 1

Expand scientific knowledge of the Earth system using NASA's unique vantage points of space, aircraft, and in situ platforms, creating an international capability to forecast and assess the health of the Earth system.

### ES Objective 1.1

Understand the consequences of land-cover and land-use changes as they impact ecological processes, and evaluate what human activities contribute to changes occurring in the landscape. Understand how changes in land cover and land use impact socio-economic activity and human health. These objectives involve developing the capability to perform repeated global inventories of land cover and land use from space and to develop the scientific understanding and models necessary to evaluate the consequences of observed changes.

**LaRC Objectives**

- Construct a 15-year survey of burned areas, through the use of Advanced Very High Resolution Radiometer (AVHRR) imagery for the entire boreal forest. Quantify the interannual variations in fire activity.
- Develop graphical maps of tropical fire patterns.
- Determine interannual variations in those patterns and develop fire-activity models.
- Analyze existing satellite measurements and develop new techniques and procedures to determine the geographical and temporal distribution of biomass burning, a major process of land cover change.
- Participate in field measurements to better understand the physics, chemistry, ecology, and dynamics of burning process in our planet's forests, grasslands, and agriculture lands.
- Develop technology and instrumentation for more accurate space measurements of the geographical and temporal distribution of burning (FireSat mission).
- Use the Lidar Atmospheric Sensing Experiment (LASE) to study the influence of soil moisture on atmospheric boundary layer (ABL) development as part of the Southern Great Plains (SGP'97) experiment.

**LaRC Longer Term Objectives**

- Develop automated techniques to detect and quantify burn area in AVHRR and Moderate Resolution Imaging Spectroradiometer (MODIS) imagery.
- Conduct analyses of the LASE SGP'97 data and establish the soil moisture and ABL relationship. Extend this analysis to other lidar data sets.

### ES Objective 1.2

Monitor, describe, and understand seasonal-to-interannual climate variability, with the aim of developing and improving capability to predict socio-economically important climatic anomalies on these time scales.

**LaRC Objectives**

- Analyze passive Stratospheric Aerosol and Gas Experiment (SAGE, SAGE II, and SAGE III) and active Lidar In-space Technology Experiment (LITE) spaceborne remote sensing data on global cloud distributions to improve understanding of radiative effects on seasonal-to-interannual time scales.

- Develop publicly available (through LaRC DAAC (Distributed Active Archive Center)) archive of climatically important global aerosol and cloud data from the 1994 Shuttle-based LITE.

- Continue to develop technologies and experimental strategies for ground-based and space-borne measurements of anthropogenically produced tropospheric aerosols.

- Continue development and utilization of the LaRC IMPACT (Interactive Modeling Project for Atmospheric Chemistry and Transport) model, a state of the art three-dimensional atmospheric simulation model with fully coupled radiation, chemistry, and dynamics to study annual and interannual variability in ozone, water vapor, and key constituents in the lower stratosphere and upper troposphere associated with natural changes in Polar Stratospheric Clouds (PSC) processing, aerosol loading, quasi-biennial oscillation, and the El Nino—Southern Oscillation.

- Conduct studies of infrared and visible climate forcing from the Mount Pinatubo aerosol cloud with advanced radiative transfer models and aerosol data derived from observations from Langley's Halogen Occultation Experiment (HALOE). These studies will assess the magnitude of short-term climate forcing from natural phenomena.

- Monitor interannual and seasonal cycles of atmospheric gases by recording and analyzing high-resolution infrared spectra at Network for the Detection of Stratospheric Change (NDSC) and complementary sites (e.g., Kitt Peak).

- Using LASE data obtained in the 1996 Tropospheric Aerosol Radiative Forcing Experiment (TARFOX), perform calculations of atmospheric radiative forcing. Continue analyses of radiative forcing with other Differential Absorption Lidar (DIAL) and LASE data sets.

- Conduct studies to define scientific requirements and to assess the availability of the technology required for the development of a geostationary satellite instrument capable of observing, with high vertical resolution, atmospheric temperature and moisture profiles and the concentration distribution of radiatively active trace gases with the time and space resolution required for process and transport detection.

- Develop scientific algorithms for retrieving the desired atmospheric variables from the radiometric observations specified for the Geostationary Atmospheric Sounder (GAS).

- Conduct theoretical and airborne studies with newly available Fourier Transform Interferometers to empirically validate the ability to achieve the scientific requirements of the GAS.

- Develop laboratory, balloon-borne, and airborne technology demonstration models which can be used to validate the engineering approach defined for the GAS.

- Using the National Polar Orbiting Environmental Satellite System (NPOESS) Airborne Sounder Testbed-Interferometer (NAST-I) participate in airborne field programs of the NASA ER-2 to obtain radiometric measurements which can be used to simulate infrared sounder observations proposed to be achieved from the NPOESS.

- Develop methods for retrieving surface and atmospheric variables (i.e., NPOESS EDR's) from the airborne NAST-I data. Test these methods with both theoretical simulations of NPOESS infrared and microwave sounding data, as well as airborne measurements with the NAST.
- Using in situ and remote sensing data obtained from ground truth sites (e.g., the DoD Cloud and Radiation Testbed (CART) sites), as well as other airborne and satellite sensors, experimentally validate the ability to achieve the specified goals of the NPOESS sounding system using the NAST-I and NAST-M (microwave) data obtained during airborne missions of the ER-2.
- Using the NAST data sets obtained for a variety of surface and atmospheric conditions and climatological regimes, improve the product retrieval algorithms and the instrument specifications to optimize the NPOESS global sounding performance.

**LaRC Longer Term Objectives**

- Analyze the time series of radiation data to improve understanding of large-scale climate anomalies such as El Nino events and volcanic eruptions.
- Develop combined lidar and passive radiometric spaceborne sensor systems for global measurements of cloud distributions and quantification of the direct and indirect radiative forcing of tropospheric aerosols.
- Utilize the LaRC IMPACT model to assess long term (decade or longer) impacts on the Earth's atmosphere from both natural and anthropogenic changes. ($CO_2$, $CH_4$, CFC's emissions from projected socio-economic development and NOx, $SO_2$ and $H_2O$ emissions associated with the proposed fleet of commercial high speed aircraft).
- Participate in the Geostationary Earth Radiation Budget (GERB) Experiment which will measure components of the Earth's radiation budget in several climate regimes on short timescales from geostationary orbit and provide the first understanding of clouds and radiation on the diurnal timescale and provide a data set for testing and improving parameterizations in General Circulation Models (GCM's) and Cloud Ensemble Models (CEM's).
- Improve retrieval capabilities for ground-based infrared monitoring of atmospheric gases, including additional gases and information on their vertical distributions.
- Develop the GAS for an NMP EO-3 mission from a geostationary satellite platform developed for either commercial broadcast, scientific research, or operational weather observation applications.
- Develop the high speed data processing and environmental product display system required for the production, dissemination, and utilization of GAS observations.
- Provide GAS products to the ES scientific research community and to National Oceanic and Atmospheric Administration (NOAA), in near real time, for demonstrating the operational utility of the data.
- Prepare and disseminate data sets for NPOESS contractors and Operational Algorithm Team (OAT) members that can be used to test data processing procedures developed for the NPOESS sounding instruments.
- Infuse new instrument and data processing technology developed at LaRC into the NPOESS sounding instrument program.

**ES Objective 1.3**

Understand Earth processes which can lead to natural disasters, develop risk assessment capability for vulnerable regions, and coordinate with U.S. disaster managers and international space agencies.

**LaRC Objectives**

- Develop instrumentation to monitor fires from space (FireSat).
- Assess the fire measurement and monitoring requirements of U. S. Government agencies for incorporation in the FireSat mission.
- Analyze cloud and radiation data sets to improve our understanding of phenomena such as El Nino events that can lead to widespread droughts, floods, and severe weather.
- Analyze the global and regional effects of volcanic eruptions in changing the climate. Determine changes in cloud physical properties due to volcanic aerosols.
- Participate in the Convection and Moisture Experiment (CAMEX III) with the LaRC LASE system during August and September 1998 to study the influence of moisture on hurricane genesis, growth, and landfall.

**LaRC Longer Term Objectives**

- Incorporate fire measurement and monitoring requirements of U. S. Government agencies in the FireSat mission.
- Coordinate space-based fire detection activities with the U.S. Forest Service (USFS), Bureau of Land Management (BLM), Department of Defense (DoD), Department of Interior (DoI), National Oceanic and Atmospheric Administration (NOAA), and Environmental Protection Agency (EPA).
- Develop a set of requirements for fire research and tactical fire surveillance satellites.
- Develop an Uncrewed Aerodynamic Vehicle (UAV) version of LASE for hurricane studies.
- Develop a satellite-based Differential Absorption Lidar (DIAL) system to study severe storms and hurricanes on global scales.

**ES Objective 1.4**

Understand the causes and consequences of long term (decades to centuries) climate variations on regional, as well as global scales, both natural and human induced.

**LaRC Objectives**

- Launch two Clouds and the Earth's Radiant Energy System (CERES) instruments on the first Earth Observing System (EOS) spacecraft to globally monitor the Earth's radiant energy system in conjunction with the Moderate Resolution Imaging Spectroradiometer (MODIS) scanning spectrometer for improved measurement of cloud physical properties.
- Analyze results from the two CERES scanners to allow the development of a new class of models for the anisotropy of the short wave and long wave radiation fields.
- Conduct follow-on field experiments similar to the First International Satellite Cloud Climatology Project (ISCCP) Regional Experiment (FIRE), Global Energy and Water Cycle Experiment (GEWEX) Continental-Scale International Project (GCIP), Baseline Surface Radiation Network (BSRN), and Atmospheric Radiation Measurement (ARM) programs to perform cloud and radiation process studies and to validate satellite-derived data sets.
- Analyze CERES data from the EOS satellites to further extend the observational database of Earth emitted and reflected radiation.
- Launch CERES instrument on the Japanese Tropical Rainfall Measuring Mission (TRMM) spacecraft to monitor the Earth's radiant energy system.
- Analyze TRMM data, including the first simultaneous measurements of clouds from the Visible Infrared Scanner (VIRS) imager, cloud liquid water (passive microwave), rainfall (active and passive microwave), and

radiation budget (CERES broadband scanner). These measurements will allow the first combined examination of the latent heat and radiative heat terms which dominate the atmospheric energy budget in the tropics.

- Use CERES data to improve parameterizations of clouds and radiation in climate prediction models.
- Conduct surface-based observation programs to improve understanding of physical processes relating to cloud formation and dissipation and to validate satellite measurements.
- Continue Earth Radiation Budget Experiment (ERBE) nonscanner measurements to extend the 13-year record of top-of-atmosphere boundary conditions to determine climate variability.
- Develop a long term database of the Earth's reflected and emitted radiation to establish a baseline for assessing global change.
- Conduct radiative transfer studies to predict the long term climate effects of altering the Earth's atmosphere by increasing carbon dioxide and other gases.
- Develop parameterizations of radiative effects of trace gases in the atmosphere. Trace gases are important in assessing climate change and in obtaining accurate retrievals from Earth-viewing satellite instruments.
- Perform analysis of long term global satellite observations and in situ high resolution aircraft measurements in conjunction with Lagrangian photochemical modeling to characterize and understand long term variations in chemically and radiatively active trace gas composition in the middle and lower stratosphere.
- Extend multidecadal data records on climatically important aerosols, ozone, and water vapor obtained from ground-based lidar and spaceborne solar occultation sensors (SAGE and SAGE II).
- Develop improved techniques for characterizing the spread and removal of volcanic aerosols from the stratosphere and for quantifying any secular change in natural (non-volcanic) background levels.
- Monitor long term trends and latitudinal variations of atmospheric gases by recording and analyzing high-resolution infrared spectra at NDSC and complementary sites.

**LaRC Longer Term Objectives**

- Complete validation of CERES scanner measurements for interdecadal comparisons with ERBE scanner measurements to detect regional and global climate changes.
- Reprocess 5-year history of ERBE scanner measurements from three satellites with improved CERES algorithms for more accurate inputs to climate models.
- Extend the long term radiation database with results from CERES instruments on future orbital missions.
- Acquire new spectroscopic data sets for minor trace species for incorporating into radiative transfer models to examine the effects on satellite retrievals and climate.
- Develop a long term database of global surface radiation budget properties for studying the causes and consequences of climate variations.
- Improve our understanding of climate feedback mechanisms and conduct analyses to separate climate forcings from the climate feedbacks.
- Conduct long term simulations with a fully coupled, three-dimensional atmospheric model with time-dependent aerosol loading and source gas emissions for comparison with observed long term behavior to evaluate the ability of atmospheric models to simulate

the combined effects of chemical and transport processes on atmospheric chemical composition.

- Operate and validate through correlative measurements the Earth Observing System (EOS) SAGE III instrument on the Russian Mesosphere-Thermosphere Emissions for Ozone Remote Sensing (METEOR) 3M mission in 1998, on the International Space Station in 2002, and on a third flight of opportunity to continue long term aerosol, ozone, and water vapor data records.
- Participate in efforts to improve calibration between NDSC instruments and between sites.

**<u>ES Objective 1.5</u>**

Map atmospheric ozone and related constituent gases and predict future changes that affect biologically active radiation and future changes that affect radiative forcing and climate.

**LaRC Objectives**

- Using Lagrangian trajectory and photochemical models in conjunction with analysis of satellite observations, provide a large-scale perspective of transport and photochemical processes in the lower stratosphere to complement high-altitude ER-2 aircraft investigations (ASHOE/MAESA, STRAT, POLARIS) designed to examine ozone loss in the Southern Hemisphere polar vortex, the morphology of long-lived tracers, and the photochemical evolution of polar stratospheric ozone in the Northern Hemisphere summer.
- Utilize three-dimensional atmospheric simulation models with fully coupled radiation, chemistry, and dynamics to study annual and interannual variability in ozone, water vapor, and key constituents in the lower stratosphere and upper troposphere due to natural changes, including PSC (Polar Stratospheric Clouds) processing, aerosol loading, quasi-biennial oscillation, and the El Nino—Southern Oscillation.
- Determine the geographical and temporal distribution of the gaseous emissions from biomass burning which lead to the photochemical production of tropospheric ozone or to the chemical destruction of stratospheric ozone.
- Install the Measurement of Atmospheric Pollution from Satellites (MAPS) instrumentation aboard the Mir Space Station to measure the seasonal and global distribution of tropospheric carbon monoxide from space with subsequent analysis via an international science team.
- Analyze and document in situ and remote measurements of aerosols, ozone, and other related trace species and processes in the troposphere that were obtained during Global Tropospheric Experiment (GTE) missions to develop a substantial understanding of human impacts on the chemistry of the global troposphere.
    - ❍ analyze the transport of ozone and ozone precursors from biomass burning and urban sources to remote, relatively pristine oceanic regions.
    - ❍ determine the tropospheric processes by which ozone and ozone precursors are vertically mixed within the atmosphere.
- Analyze measurements of aircraft emissions (Subsonic Assessment (SASS) project) to determine their impact on the environment.
- Participate in field experiments to measure gaseous and particulate emissions from biomass burning with focus on chemical emission composition as a function of combustion intensity and vegetation type.
- Continue high vertical resolution, near-global measurement record of ozone, aerosols, and nitrogen dioxide from SAGE II.

- Develop improved algorithms for processing solar occultation measurements to better quantify long term global trends and variability in ozone and aerosols.
- Use SAGE II multiwavelength extinction measurements to estimate stratospheric aerosol surface area and volume distributions for use in parameterizing ozone-destructive heterogeneous chemical processes in global photochemical models.
- Develop and validate techniques for extending SAGE II ozone retrievals downward from the stratosphere to improve our understanding of tropospheric ozone distributions and trends.
- Use LITE and SAGE data to study the distribution and variability of aerosols in the upper troposphere, including those produced by biomass burning, to aid in assessing their impact on tropospheric ozone.
- Record high resolution atmospheric infrared spectra over broadband passes to obtain simultaneous measurements of many species (from ground, balloon, and space).
- Use the LaRC airborne UV Differential Absorption Lidar (DIAL) system in NASA missions to measure distributions of aerosols and ozone to help validate new space-based ozone-measuring instruments. Understand the DIAL technology for eventual application in space.
- Continue to develop and enhance satellite data analysis techniques for producing tropospheric ozone distribution products from existing NASA satellite instrument data sets.

**LaRC Longer Term Objectives**

- Participate in future high-altitude ER-2 field campaigns in support of SAGE III and EOS AM-1 validation efforts by providing trajectory mapping capabilities for comparison between in situ and multiple satellite observations of ozone, aerosols, and other key species primarily involved in ozone production and loss processes.
- Expand the capability of the LaRC IMPACT model to simulate chemical processes in the troposphere to include wet and dry deposition, global source inventories of NOx emissions, and tropospheric hydrocarbon chemistry using modified chemistry algorithms which have been compared with consensus results from a recent IPCC (Intergovernmental Panel on Climate Change) photochemical model comparison.
- Develop weekly maps showing the locations of gaseous emissions from biomass burning.
- Extend current studies of climate forcing from stratospheric aerosols to study the role of stratospheric ozone variability in climate forcing. This work will use long term data sets gathered by SAGE and HALOE with advanced radiative transfer routines and should eventually be included in international assessments of radiation and climate.
- Develop the following improved sensor systems and techniques for the measurement of concentrations and fluxes of tropospheric trace species:
    - Fast response (10 Hz) ozone sensor
    - Ozone sensor capable of unattended operation
    - $CO_2$ sensor for eddy-correlation flux studies
    - Three-dimensional hot wire sensor for microwave turbulence measurements
    - Relaxed eddy accumulation technique for the measurement of nonmethane hydrocarbons
    - Turbulent air motion technique for measuring the dynamics and vertical flux of trace gases in the boundary layer
- Conduct airborne studies to determine

  - ❍ Convective transport of tropospheric species
  - ❍ Production of NOx by lightning
  - ❍ Gas to particle conversion processes
  - ❍ Trace species exchange over ocean upwelling and globally important ecosystems

- Manage and direct field experiments to
  - ❍ Improve our understanding of the role of clouds in climate and climate change (FIRE)
  - ❍ Contribute to the scientific understanding of human impacts on the chemistry of the global troposphere (GTE)
- Develop high speed data acquisition, analysis, and display systems for measurement of trace gases and turbulent air motions from aircraft.
- Continue high vertical resolution, near-global measurement record of ozone, aerosols, and nitrogen dioxide from SAGE II.
- Obtain and validate aerosol, ozone, nitrogen dioxide and trioxide, and chlorine dioxide measurements into the next century with the EOS SAGE III instruments on the Russian METEOR 3M mission, the International Space Station, and a third flight of opportunity.
- Continuous improvement of capabilities to obtain information on more species from atmospheric spectral data, including measurement and analysis of laboratory spectra where needed.
- Develop a differential absorption lidar system to measure both stratospheric and tropospheric ozone from space. A future space-based ozone and aerosol lidar system, called the Ozone Research and Advanced Cooperative Lidar Experiments (ORACLE) to be developed jointly by NASA and the Canadian Space Agency is in the study phase.
- Improve characterization of the global ozone distribution (stratospheric and tropospheric) and of long term changes in this distribution by the use of existing and planned satellite data sets. Enable determination of mesoscale structure in total ozone field, as well as a monitoring capability for tropospheric pollution formation and transport, through implementation of geostationary observations.
- Improve the understanding of anthropogenic and natural processes that control tropospheric ozone levels.
- Develop a tropospheric chemistry science mission for a platform in geostationary orbit.

## ES Enterprise Goal 2

Disseminate information about the Earth system.

### <u>ES Objective 2.1</u>

Implement data system architectures that are open, distributed, and responsive to user needs.

**LaRC Objectives**

- Develop and operate the LaRC Tropical Rainfall Measuring Mission (TRMM) Information System (LaTIS) to provide processing, archival, and distribution of data from the CERES experiment on the 1997 TRMM.
- Develop Pathfinder data sets from satellite-based measurements, including cloud physical and microphysical properties, shortwave and long wave radiative fluxes, and clear-sky radiative properties. Use the data sets to evaluate effectiveness of system structures.
- Provide improved World Wide Web search interface for CERES data products.
- Provide results from the EOS Data and Information System (EOSDIS) Community Cost Model to allow evaluation of costs for alternative architectures.

- Distribute SAGE standard data products (e.g., aerosol extinction, ozone, and cloud occurrence) on a continuing basis through the LaRC DAAC.
- Distribute SAGE higher level aerosol data products (e.g., global optical depth and surface areas) via Internet home page.
- Operate and enhance the LaRC Version 0 processing, archive, and distribution system to support pre-EOS research in key atmospheric science discipline areas (radiation budget, clouds, aerosols, and tropospheric chemistry).
- Advertise and distribute GTE data through the World Wide Web.

**LaRC Longer Term Objectives**

- Provide processing, archival, and distribution of data from the CERES, Multi-Angle Imaging Spectro-Radiometer (MISR), and Measurements of Pollution in the Troposphere (MOPITT) experiments on the 1998 EOS AM-1 mission and from the SAGE III experiment on the 1998 Russian METEOR (Mesosphere-Thermosphere Emissions for Ozone Remote Sensing) 3M mission.
- Distribute LITE Level 1 data products through the LaRC DAAC.
- Provide global data sets on the Earth's radiation budget through the LaRC DAAC and the EOSDIS.
- Provide subsetting and indexing capability for CERES data products that will allow users to find data for specialized needs.
- Develop scientific and technological partnerships to meet future ES data processing, archival, and distribution requirements.

**ES Objective 2.2**

Foster the development of an informed and environmentally aware public.

**LaRC Objectives**

- Collaborate with the LaRC Office of Education.
- Develop the Students' Cloud Observations On-Line (S'COOL) program for educational outreach to involve students in ES research and promote interest in science.
- Prepare educational exhibits on LaRC ES atmospheric sciences research and accomplishments.
- Create a document on LaRC research activities and accomplishments in the atmospheric sciences for public distribution.
- Develop and administer EDCATS forms for outreach programs.
- Provide unique and innovative materials electronically via the World Wide Web that explain SAGE II, SAGE III, and LITE and why they are important to our understanding of climate and atmospheric chemistry.
- Develop and maintain World Wide Web home page on aerosol lidar programs and their contribution to understanding climate change and atmospheric effects of aircraft.
- Provide material and personnel to highlight and explain ES research and other activities to the general public through the Public Affairs Office.
- Provide ES research results via the World Wide Web and explain the importance of the research.
- Implement a World Wide Web data search and order system that encourages general access to the broad range of data and information at the LaRC DAAC.
- In partnership with LaRC Office of Education and educators, develop specialized products that enable educators to incorporate atmospheric science concepts into their classrooms.

- Support educational outreach missions.
- Mentor pilot classrooms during Earth KAM missions.
- Organize and coordinate Earthwatch summer research camps.
- Support GLOBE (Global Learning and Observations to Benefit the Environment).

**LaRC Longer Term Objectives**

- Expand the Students' Cloud Observations On-Line (S'COOL) program to be national and international in scope. Expand the program to include senior citizen groups.
- Expand program in education and outreach on LaRC's research and accomplishments in the atmospheric sciences.
- Expand Internet access to additional data sets and teaching materials.
- Support student enrichment and research opportunities to train the next generation of Earth system scientists for analysis of large-format data sets expected from future advanced atmospheric remote sensors.
- Make tropospheric trace species information and assessments accessible to ES information customers, including the general public, media, publishers, and industry.
- Organize and coordinate future Earthwatch research camps.
- Collaborate with LaRC Office of Education and the Learning Technologies Project (LTP) in development of innovative distance learning projects for precollege audiences.

## ES Enterprise Goal 3

Enable the productive use of ES science and technology in the public and private sectors.

**<u>ES Objective 3.1</u>**

Develop, infuse, and transfer advanced remote sensing technology and concepts.

**LaRC Objectives**

- As a member of the Technology Strategy Team, contribute to the generation, update, and review of the ES Technology Investment Plan.
- Review and adjust the remote sensing technology program based on the requirements identified in the ES Integrated Technology Development Plan.
- Continue development of advanced sensors to measure stratospheric ozone, temperature, water vapor, and other chemical species by applying advanced technologies to innovative systems concepts.
- Continue design of a passively cooled infrared emission limb sounder capable of measuring stratospheric temperature and ozone. Passive cooling removes significant cost and risk associated with active cryocoolers and allows for long instrument life.
- Apply advanced technology in the area of Fourier transform spectrometry (FTS) to sense cirrus cloud ice content and ice water path.
- Develop and transfer to industry advanced (e.g., Gas and Aerosol Monitoring Sensorcraft (GAMS)) technologies for low-cost solar-occultation measurements of atmospheric constituents.
- Explore advanced sensor concepts for radiation budget, including sensor arrays and highly absorbent coatings.
- Provide high-resolution atmospheric spectral for other remote sensing experiments.
- Develop advanced Differential Absorption Lidar (DIAL) systems for remote measurement of ozone and water vapor, use these

systems in field programs, and, through meetings and publications, share knowledge of these systems with industry, universities, and other government agencies.

- Define, develop, and characterize an ozone sensor for scientifically meaningful measurements of trace atmospheric species (i.e., ozone) from a geostationary platform (Geo Express Pathfinder).
- Implement and evaluate new methods and procedures for simulating advanced atmospheric remote sensor data, including atmospheric radiative transfer calculations and subsequent propagation through measuring instrumentation.
- Continue feasibility assessment of global tropospheric and total ozone monitoring from a space-based platform employing Fabry-Perot Interferometry (FPI).
- Perform proof-of-concept activities for the development of an advanced tropospheric ozone remote sensor. Enhance and implement Fabry-Perot technologies into ozone spectrometer test bed and perform validation testing, including ground-based measurements of solar absorption spectra.
- Transfer 2-micron solid state laser technology to industry for infusion into New Millenium Program WINDS mission (EO-2).
- Demonstrate utility of reflected GPS signals for ionospheric total electron concentration mapping, wetlands mapping, and sea state scatterometry applications.
- Develop and transfer synthetic thinned array radiometer (STAR) technology to GSFC for soil moisture measurments.

**LaRC Longer Term Objectives**

- Develop and transfer to the private sector a multispectral Earth-imaging satellite instrument engineering design. Instrument is to be built, launched, and operated in the private sector.
- Deploy an FTS on an aircraft to make proof of concept flights for sensing of cirrus clouds.
- Make GAMS-like technologies available on National Polar Orbiting Environmental Satellite System (NPOESS) to customers in operational atmospheric monitoring and the space sciences.
- Develop, in partnership with industry, technologies that will make possible future long-duration satellite-based lidars for measurements of clouds and aerosols.
- Continue contributions to improve the High Resolution Transmittance (HITRAN) and other atmospheric spectroscopic parameters databases.
- Advise the University of Hawaii on development of their ground-based water vapor lidar system, and validate its measurements using the LaRC LASE system.
- Develop next-generation DIAL systems for space and UAV platforms, including the satellite-based instrument Active Remote Sensing of Water Vapor from Space (AROWS).
- Expand the Fabry-Perot Interferometer (FPI) feasibility assessment to include other important tropospheric trace species.
- Evolve and implement laboratory prototype FPI test bed into a nadir-viewing configuration for operation on an above-ground platform (e.g., balloon or aircraft).
- Develop and enhance geophysical parameter retrieval, data analysis and assimilation, and geolocation techniques for improving and optimizing interpretation of science data from geostationary orbit.
- Support Stennis Space Center in the definition, development, and implementation of a program which will provide cost-effective

access to geosynchronous orbit via commercial providers.

- Design, develop, launch, and operate the Gas and Aerosol Monitoring Sensorcraft (GAMS) as a New Millennium flight validation mission.
- Develop compact, high efficiency, high energy, solid-state lidar systems for future ES atmospheric science applications.
- Develop licensing agreements with U.S. industry for commercial applications of passive and active remote sensing technology.
- Encourage use of atmospheric science information by nontraditional customers through easy and modern access techniques and targeted outreach activities.

**ES Objective 3.2**

Extend the use of NASA's research and technology beyond the traditional science community to be applied to the needs of national, state, and local users.

**LaRC Objectives**

- Publicize the availability of solar radiation data sets for use in solar power planning applications.
- Explore the detection and monitoring of forest fires from satellites and provide these data to the Forest Service and other resource management agencies.
- Assess the needs and requirements of U. S. Government agencies in fire measurement and monitoring using FireSat technology.
- Study the impact of acid rain and ozone on the eastern U.S. forests and disseminate the findings.
- Develop and enhance techniques for jet stream position identification with high spatial resolution total column ozone data sets (to be obtained from geostationary platforms).
- Disseminate the results of demonstration and pathfinder projects and partnerships through a wide variety of venues and outreach activities including museums and science centers.
- Implement World Wide Web technology to enable access to archived data sets and products via the Internet.
- Provide regional air quality monitoring to enable informed public policy decisions.
- Incorporate access to nonscience products of interest to state, local, and commercial customers into the DAAC.

**LaRC Longer Term Objectives**

- Provide regional, global surface solar data for applications of solar power for energy conservation and for third-world efforts in using solar-powered devices for cooking, refrigeration, and other domestic tasks.
- Using the results from Earth radiation budget satellites, provide Photosynthetically Active Radiation (PAR) data to the agricultural community.
- Develop FireSat/Vista mission of remote sensing of fires for applications of national, state, and local users.
- Develop space-based remote sensing mission concepts that will enable better quantification of anthropogenic aerosol direct and indirect radiative forcing so that policy makers worldwide can make informed decisions concerning control of the production of aerosols.

**ES Objective 3.3**

Support the development and leverage commercial capabilities in remote sensing and information systems to cost-effectively meet ES science objectives and to enhance the relevance of ES scientific discovery.

**LaRC Objectives**

- Develop the FireSat instrument concept for the commercial remote sensing mission, Vista, to provide measurements of the global and temporal distribution of fires for scientific use and to provide fire measurements for operational activities of other U.S. Government agencies (e.g., U.S. Forest Service and Bureau of Land Management).

- Use commercially developed mission operations software and data handling systems from previous missions (SAGE, HALOE) to serve the current (SAGE III) and future program (SABER (Sounding of the Atmosphere Using Broadband Emission Radiometry)) needs in mission operations. These systems are essentially ported over and configured for the current mission at substantially less cost than would be required to develop them from scratch.

- Develop and implement mission enabling insertion of an atmospheric science payload into geostationary orbit (Geo Express Pathfinder) as a secondary payload on a commercial satellite; leverage commercial assets to reduce cost and increase earth environmental sensing capability.

- Establish partnerships with commercial firms to offset risk and cost associated with development of new data products.

- Participate in university, industry, and government partnerships to foster the development of advanced atmospheric remote sensor technologies via Memorandum Of Agreement and similar arrangements.

- Work with the Stennis Commercial Remote Sensing Program Office to identify and promote commercial applications of advanced concepts and technology.

- Participate with the Technology Applications Group (TAG) in the identification of nonaerospace applications of remote sensing technology.

**LaRC Longer Term Objectives**

- Provide mission guidance and science leadership for the development of a NASA designed, commercially built Earth-imaging satellite instrument.

- Explore the usefulness of radiative transfer and surface and cloud climatologies for architectural and illumination engineering design applications.

- Collaborate with Stennis Space Center to develop a process for continuing access to geostationary orbit via commercial satellites.

**<u>ES Objective 3.4</u>**

Make major scientific contributions to regional, national, and international environmental assessments.

**LaRC Objectives**

- Contribute fundamental observations of radiative forcing and feedback to the Intergovernmental Panel on Climate Change (IPCC) for assessment studies.

- Provide a large-scale prospective of atmospheric transport and chemistry for assessments of potential effects of stratospheric aircraft during ASHOE/MAESA and POLARIS high-altitude ER-2 aircraft investigations by combining remote satellite and in situ observations of ozone and other key species through Lagrangian trajectory/photochemical modeling.

- Contribute SAGE and lidar data on aerosols and ozone, and serve as lead and contributing authors, to the 1998 United Nations Environment Programme/World Meteorological Organization (UNEP/WMO) international ozone assessment.

- Use the airborne DIAL system to study the impact of civil aircraft emissions on ozone concentrations, the impact of biomass burning on aerosol and ozone distributions, and the global climate change.

**LaRC Longer Term Objectives**

- Contribute results of climate process studies and fundamental observations of radiative forcing and feedback to the Intergovernmental Panel on Climate Change.
- Conduct long term, coupled, three-dimensional atmospheric radiation, chemistry, and dynamics simulations for comparison with two-dimensional assessment model simulations for Atmospheric Effects of Aviation Project (AEAP) and IPCC assessments.
- Provide data on aerosols and ozone and contribute as authors and reviewers for future UNEP/WMO international ozone assessments.
- Contribute data and provide authorship and reviews to future assessments of the potential atmospheric effects of supersonic and subsonic aircraft.
- Using the LASE instrument, participate in future regional, national, and international field experiments to study cirrus clouds, upper tropospheric water vapor, and the Arctic and Antarctic stratosphere.
- Provide ozone measurements, modeling, and analyses in support of the Intergovernmental Panel on Climate Change's periodic reports.

# Section III—Specific Roles in Support of Space Science Enterprise

Four broad Space Science Enterprise goals; Science (I and II), Technology (III), and Education and Outreach (IV); are supported by specific goals and objectives. Langley has a role in each of these areas and generally Langley's activities cover a multitude of goals within each area. Langley supports all 11 Science goals, 1 goal in the Technology area, and 5 Education and Outreach goals.

## Space Science Enterprise Goals I and II

***Science (I)***—Establish a virtual presence throughout the solar system, and probe deeper into the mysteries of the universe and life on Earth and beyond.

***Science (II)***—Pursue space science programs that enable and are enabled by future human exploration beyond low-Earth orbit.

**Science Goals**

1. Understand how structure in our Universe (e.g., clusters of galaxies) emerged from the Big Bang.
2. Test physical theories and reveal new phenomena throughout the universe, especially through the investigation of extreme environments.
3. Understand how both dark and luminous matter determine the geometry and fate of the universe.
4. Understand the dynamical and chemical evolution of galaxies and stars and how the exchange of matter and energy move among stars and the interstellar medium.
5. Understand how stars and planetary systems form together.
6. Understand the nature and history of our solar system, and what makes Earth similar to and different from its planetary neighbors.
7. Understand mechanisms of long and short term solar variability and the specific processes by which Earth and other planets respond.
8. Understand the origin and evolution of life on Earth.
9. Understand the external forces, including comet and asteroid impacts, that affect life and the habitability of Earth.
10. Identify locales and resources for future human habitation within the solar system.
11. Understand how life may originate and persist beyond Earth.

| Science Goals | Sun-Earth Connection | Planetary Entry | Space & Systems Analysis | Enterprise Support |
|---|---|---|---|---|
| 1 | | | X | X |
| 2 | | | X | X |
| 3 | | | X | X |
| 4 | | | X | X |
| 5 | | | X | X |
| 6 | X | X | X | X |
| 7 | X | | X | X |
| 8 | | X | X | X |
| 9 | | | X | X |
| 10 | | X | X | X |
| 11 | | X | X | X |

## A. Sun-Earth Connection

Sun-Earth Connection is a program to observe and interpret the variable radiations in the Earth's space environment. The Sun, its atmosphere and heliosphere, and the Earth's magnetosphere and atmosphere are coupled by physical processes that are only partially known. These processes will be explored to achieve major advances in understanding.

### LaRC Objectives

- Develop and operate the Sounding of the Atmosphere Using Broadband Emission Radiometry (SABER) instrument on the Thermosphere, Ionosphere, Mesophere Energy and Dynamics (TIMED) Mission. Conduct scientific investigations that substantially contribute to our knowledge of the energetics, chemistry, dynamics, and transport of the mesosphere and lower thermosphere and ionosphere and the relationship to solar activity.
- Provide management and scientific oversight of SABER flight instrument development, leading to a launch on schedule (January 2000).
- Lead the SABER science team in the development of algorithms for the retrieval of atmospheric data from the flight instrument data.
- Provide management and scientific oversight of SABER mission operations and data analysis software.
- Provide management and scientific oversight of SABER instrument operations (2000–2002).
- Conduct scientific investigations of the energetics, chemistry, dynamics, and transport of the mesosphere and lower thermosphere in collaboration with the SABER and TIMED science teams.

## B. Planetary Entry

### LaRC Objectives

- Perform Mars Pathfinder atmospheric flight reconstruction to validate aerothermodynamic and flight dynamic design models, and apply data to Mars 1998 Lander mission.
- Support aerobraking of Mars Global Surveyor spacecraft.
- Support design of Stardust entry vehicle.
- Determine aeroshell configuration and support design of Mars Microprobes (New Millennium DS-2 mission).

### LaRC Longer Term Objectives

- Support Mars Surveyor 1998 mission design (aerobraking and direct entry).
- Support Mars Surveyor 2001 aerocapture and precision landing design.
- Develop candidate guidance concepts and aerodynamic database for Mars Surveyor 2001 missions.
- Lead atmospheric flight team in support of Mars Surveyor 2001 mission design.
- Develop guidance system testbed to simulate and evaluate a range of atmospheric guidance options applicable to the 2001 aerocapture and precision landing goals.
- Support aeroassist technology development for the Mars Surveyor 2003 and 2005 missions.
- Explore Mars ascent vehicle design space and trades for sample-return mission.
- Evaluate and develop innovative sample-return capsule designs.
- Develop and integrate analysis models for ARC, JPL, and LaRC Integrated Design System for planetary entry vehicles.

- Develop and implement planetary entry analysis tools for robotic and human space flight missions including operational, development, and conceptual systems for Earth orbit and planetary systems.

**C. <u>Space And Systems Analysis</u>**

**LaRC Objectives**

- Conduct space mission and systems analysis of space transportation, spacecraft, planetary entry, and sensor concepts. Lead independent assessments of critical space missions for the Agency.
- Conduct technology assessments to enhance space transportation, spacecraft, planetary entry, and sensor concepts.
- Conceive, develop, and implement computational, multidisciplinary optimization for design and development of space and trans-space transportation vehicle systems.
- Develop life-cycle analysis capability (including cost) to support independent assessments of the early conceptual stages of projects and programs for the purposes of making informed decisions on selection as well as investment choices for the Agency.
- Develop and utilize spacecraft and space transportation vehicle preliminary design and mission design and evaluation tools for application to LaRC flight mission concepts, Agency space mission concepts, and independent assessment evaluations.

**D. <u>Enterprise Support</u>**

**LaRC Objectives**

- Develop Announcement of Opportunity and NASA Research Announcements.
- Manage the proposal evaluation process.
- Conduct technical, management, cost, and other program factor evaluations.
- Manage the proposal selection process and support Office of Space Science recommendation and selection activities.
- Manage the Space Science Support Contract.

## Space Science Enterprise Goal III

***Technology (III)*****—**Develop and utilize revolutionary technologies for missions impossible in prior decades.

**<u>Technology Goal 1</u>**

Lower mission life-cycle costs and provide critical new capabilities through aggressive technology development.

**LaRC Objectives**

- Transfer polymide-based circuits to aerospace industry.
- Develop high precision piezoelectric actuators capable of operation at cryogenic temperatures.
- Demonstrate pathfinder rapid modeling and analytical simulations for combined mechanical and thermal loads.
- Demonstrate multidisciplinary prototype analysis and design system utilizing computational intelligent simulations with structures, dynamics, thermal management, manufacturing costs, and risk/uncertainty management.
- Complete proof of concept inflatable-rigidizable wave guide for materials and analysis assessment.
- Complete low-cost composite precision deployable reflector.

**LaRC Longer Term Objectives**

- Develop and characterize thin-film and fabric materials for inflatable structures.
- Develop analytical tools for modeling non-linear structural mechanics and wrinkling of inflatable members.
- Conduct analysis and validation of industry concepts which offer reduced fabrication time and cost for light-weight composite structures.
- Develop concepts for lightweight high payload volume, protective sample-return, aero-shell spacecraft.
- Develop and test concepts for collapsible structures to absorb landing impact.
- Flight validate conformal radiation shielding material for microelectronics.
- Develop and test proof-of-concept chip on structure panel.
- Demonstrate Digital Signal Processing (DSP) chip on board for high speed data processing.

## Space Science Enterprise Goal IV

***Education And Public Outreach (IV)*****—**Contribute measurably to achieving the science, mathematics, and technology education goals of our Nation, and share widely the excitement and inspiration of our missions and discoveries.

**Education and Public Outreach Goals**

- Use our missions and research programs and the talents of the space science community to contribute measurably to efforts to reform science, mathematics, and technology education, particularly at the pre-college level, and the general elevation of scientific and technical understanding throughout the country.
- Cultivate and facilitate the development of strong and lasting partnerships between the space science community and the communities responsible for science, mathematics, and technology education.
- Contribute to the creation of the talented scientific and technical workforce needed for the 21st century.
- Promote the involvement of underserved and underutilized groups in Space Science education and outreach programs and in Space Science research and development activities.
- Share the excitement of discoveries and knowledge generated by Space Science missions and research programs with the public.

**LaRC Objectives**

- Evaluate how well proposals submitted to the Office of Space Science in response to Announcements of Opportunity and NASA Research Announcements meet the stated goals.
- Support the Office of Space Science recommendation and selection processes as they relate to the Education and Public Outreach goals.

# Section IV—Specific Roles in Support of Human Exploration and Development of Space Enterprise

The NASA 1998 Strategic Plan provides direction for the Agency's long range plans for sustaining human presence in space. The Langley Research Center serves a fundamental role in supporting the Human Exploration and Development of Space (HEDS) Enterprise goals, objectives, and strategies as identified in the time-phased Human Exploration and Development of Space Road Map in the Strategic Plan, through the Center's innovative research activities and state-of-the-art systems analysis. Specific objectives of Langley in support of HEDS are cited under each HEDS objective that is supported.

## HEDS Enterprise Goal 1

Use the environment of space to expand scientific knowledge.

### HEDS Objective 1.1

Expand scientific knowledge by exploring the role of gravity and the space environment in physical, chemical, and biological processes through a vigorous peer reviewed research program in space.

**LaRC Objectives**

- Deliver and conduct the flight of microgravity investigations in the discipline of materials science aboard the Space Shuttle United States Microgravity Payload 3 (USMP3) and United States Microgravity Payload 4 (USMP4) flights.
- Integrate and conduct the flight of materials and structural dynamics flight experiments aboard the Space Shuttle.
  - ❍ Photogrammetric Appendage Structural Dynamic Experiment (PASDE)
- Conduct materials and structural dynamics experiments aboard the Mir space station.
  - ❍ Mir Environmental Effects Payload (MEEP)
  - ❍ Materials in Devices as Superconductors (MIDAS)
  - ❍ Enhanced Dynamic Load Sensors (EDLS)
- Conduct materials experiments on the Mars 2001 mission.
  - ❍ Martian Exposure Facility (MEF)
- Conduct research to understand interactions of microgravity and materials science processes.
- Develop research strategies to utilize the microgravity environment to improve the performance of high technology materials.
- Investigate the suitability of very low-gravity experiment facilities through the use of unpiloted spacecraft, co-orbiting with the International Space Station (ISS) for those investigations of high scientific and technological value that cannot be accomplished on the Space Shuttle or the ISS.

## HEDS Enterprise Goal 2

Prepare to conduct human missions of exploration to planetary and other bodies in the solar system.

### HEDS Objective 2.1

With the Space Science Enterprise, carry out an integrated program of robotic exploration of Mars to characterize the potential for human exploration of Mars to support definition decisions or human exploration as early as 2005.

**LaRC Objectives**

- Reconstruct the actual Mars Pathfinder entry profile to enhance future mission entry design.
- Support the entry and precision landing analysis, design, and operations for the Mars 1998, 2001, 2003, and 2005 mission opportunities.
- Support the aeroshell design and selection for the 2001, 2003, and 2005 Mars mission opportunities.
- Support the characterization of space transit and surface radiation environments to which missions will be exposed to protect humans and shield microelectronic devices.
- Develop a Martian Exposure Facility (MEF) for the 2001 Mars mission to characterize the effects of the Martian environment on materials necessary to enable the human exploration of Mars.
- Conduct independent assessments of future Mars robotic missions to ensure design suitability, cost realism, schedule realism, and technical feasibility.

**HEDS Objective 2.2**

Establish the requirements and architecture for human exploration that can radically reduce cost through the use of local solar system resources, advanced propulsion technologies, commercial participation, and other advanced technologies.

**LaRC Objectives**

- As the Center of Excellence for Structures and Materials, support HEDS mission architecture and technology development with emphasis on advanced composites, inflatable structures, and radiation protection materials.
- Support transportation architecture studies to define innovative concepts for human exploration including the Solar Electric Power Propulsion (SEP) study.
- Conduct aerobrake utilization studies, including the Mars TransHab Aeroshell, to assess mission architecture implications and identify technology investment requirements.
- Conduct assessments to identify systems and technologies to meet HEDS mission precision landing and vehicle guidance, navigation, and control requirements.
- Support the definition of cost-effective Heavy Lift launch vehicle concepts to enable human exploration.

**HEDS Objective 2.3**

Advance biomedical knowledge and technologies to maintain human health and performance on long-duration missions before the year 2008.

**LaRC Objectives**

- Conduct research and flight experiments on advanced protective shield materials to reduce the risk to humans from space radiation.
- Develop integrated vehicle and radiation protection concepts to reduce the risk to humans from space radiation during long-duration transit and surface stay time.

## HEDS Enterprise Goal 3

Provide safe and affordable human access to space, establish a human presence in space, and share the human experience of being in space.

**HEDS Objective 3.1**

Sustain Space Shuttle program by safely flying scheduled missions and aggressively pursuing a systems upgrade program that will reduce payload-to-orbit costs by a factor of 2 by 2002.

**LaRC Objectives**

- Support Phase IV Space Shuttle Upgrades including aerothermodynamic characterization of Liquid Fly-Back Booster (LFBB) configurations.

- Support Space Shuttle Super Light Weight Tank component testing.

**HEDS Objective 3.2**

Expand a permanent human presence in low-Earth orbit by transitioning from Mir to the International Space Station (ISS) program in order to enhance and maximize science, technology, and commercial objectives.

**LaRC Objectives**

- Provide systems analysis engineering support to the Headquarters Advanced Projects Office (Code MP) to
    - ❍ Assess and develop an ISS evolution plan to meet long term HEDS requirements
    - ❍ Define and prioritize Office of Space Flight technology requirements and advanced development and flight demonstration projects to be flown aboard ISS to meet current and future HEDS requirements
    - ❍ Identify and assess candidate improvements to the current ISS design which could reduce operating costs, improve margins, safety, performance, and operability
- Provide systems analysis engineering support to the ISS Program Office Chief Engineer to support risk mitigation and critical nonbaseline assessments.
- Participate in the development of an advanced Phased Array communications system for ISS to enhance telescience capabilities.
- Conduct risk mitigation experiments as part of the Phase I Program, such as the Mir Environmental Effects Payload (MEEP), to support ISS design and verification.
- Continue to work with private industry to define ISS payload commercialization facilities.

**HEDS Objective 3.4**

Involve citizens in the adventure of exploring space, engage educators and students to promote educational excellence, and use human space flight to promote international cooperation.

**LaRC Objectives**

- Collaborate with the LaRC Office of Education in production, development, dissemination, and evaluation of education outreach programs.
- Expose the educational community to the goals and benefits of human flight endeavors by sponsoring a number of annual teacher enrichment and training programs at LaRC.
- Provide direct interaction between NASA personnel and students through outreach activities including National Engineers Week volunteers, National Science Olympiad sponsorship, state fair demonstration, and public broadcast educational programs.
- Use the Internet to provide direct involvement of the public and educational communities for participation in exploration definition and achievement.
- Enhance the curriculum of educators with information and materials generated by the HEDS Enterprise programs, technologies, and discoveries.
- Provide distance learning capabilities to schools through an interactive television system provided by NASA.
- Provide facilities and resources at LaRC for Universities offering advanced degrees in aerospace engineering and management.
- Utilize the Martian Exposure Facility to engage the public and educational sectors in the development of exploration technologies.
- Join with other nations in the international exploration and settlement of space.

- In cooperation with other nations, design an international strategy for exploring the Moon and Mars.

**HEDS Objective 3.5**

Invest in advanced concepts that may produce breakthroughs in human exploration and commercial development of space.

**LaRC Objectives**

- Lead the Agency's research and development of advanced structures and materials technologies to support future space transportation system design and development.
  - Develop vehicle structural designs.
  - Develop light weight thermal protection systems.
  - Conduct light weight component experiments.
  - Develop integrated vehicle and radiation protection materials to reduce the risk to humans from space radiation during long duration transit and surface time.
- Conduct systems analyses of future space transportation system design concepts (e.g. aerobrakes, configurations), operations, and associated technologies to support HEDS mission requirements, including aerodynamics, aerothermodynamics, trajectories, flight dynamics, guidance and control, and precision landing.
- Continue the development of microcontrollers and flexible, light weight power system components to support reduced mass, volume, and power requirements.
- Continue the development of advanced real-time on-board digital signal processing capacity necessary to meet future human mission requirements.
- Develop partnerships with industry to conduct feasibility studies to identify potential commercialization opportunities which augment current Space Shuttle and future ISS capabilities.

## HEDS Enterprise Goal 4

Enable the commercial development of space and share HEDS knowledge, technologies, and assets that promise to enhance the quality of life on Earth.

**HEDS Objective 4.1**

Transfer knowledge and technologies, and promote partnerships to improve health and enhance the quality of life.

**LaRC Objectives**

- Involve industry, universities, and other agencies in the strategic planning process through strategic alliances and partnerships.
- Leverage LaRC aerospace research and development activities to better enable nonaerospace and small businesses to compete in the world market.
- Continue to promote and enhance the existing technology transfer program at LaRC which fosters technology reinvestment, contributes to the economic competitiveness of the United States commercial sector, and assists industry in the development of commercial products and services for introduction into the global marketplace.
- Showcase LaRC research and technology activities to the commercial sector through a biannual open house.

**HEDS Objective 4.2**

Facilitate the use of space for commercial products and services resulting in the participation of at least 200 private firms by the year 2002, and a 100 percent increase in the level of industry-committed resources by 2005.

**LaRC Objective**

- Assess the feasibility of a commercially developed Space Solar Power infrastructure concept to provide worldwide clean and safe electrical power.

# Section V—Core Competencies

Core competencies are the distinguishing integration of skills, facilities, and technological capabilities that provide Langley with the unique capacity to perform its mission and programs. These core competencies differentiate Langley from other organizations, are essential to accomplishing the Center mission, and are extendible to new applications in both aerospace and nonaerospace industries.

The figure below depicts Langley's Core Competencies at the highest level. The Core Competency elements are used to implement the research programs listed in Sections I-IV. The Mission and Systems elements are provided by researchers in the Airframe Systems Program Office (ASPO), the Aerospace Transportation Technology Office (ATTO), and the Space and Atmospheric Sciences Program Group (SASPG). The research disciplines depicted across the middle of the icon are performed by engineers and scientists in the Research and Technology Group (RTG) and SASPG. An integral element of each research discipline is the supporting tools (depicted across the bottom) which are provided by personnel from the Internal Operations Group (IOG).

In addition to the technical competencies listed below, LaRC possesses the Technology Program Management core competency that includes the ability to conceive and manage complex Technology Development Programs. This competency is manifested by leadership of numerous Technology Development Programs of extreme importance to the Agency and the Nation. This competency requires the ability to create national alliances to leverage technologies and to carry concepts to application.

## Mission and Systems Analysis, Integration, and Assessment

### Aeronautics

- Identify and prioritize new aeronautical concepts and systems, including the critical technologies involved, investment options, and system-level global and societal benefits resulting from proposed programs for subsonic through hypersonic speed vehicles.
- Provide continuing evaluations and technology assessments for ongoing focused and base programs.
- Develop advanced methods and data for performance, economic, and safety assessments of aeronautical systems, including vehicles and the integrated air transportation system.
- Conceive, develop, and validate multidisciplinary methods for analysis and design of aerospace systems and products.

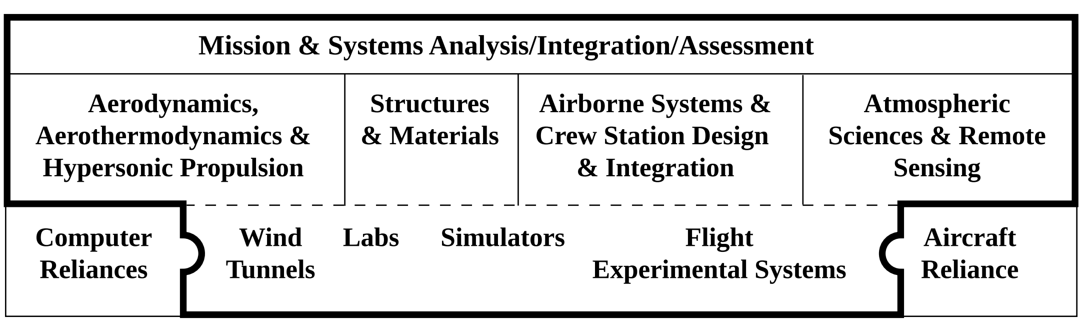


Figure 2. Langley core competencies.

**Space**

- Conduct mission and systems analysis of space transportation, spacecraft, planetary entry, and sensor concepts. Lead independent assessments of critical space missions for the Agency.
- Conduct technology assessments to enhance space transportation, spacecraft, planetary entry, and sensor concepts.
- Conceive, develop, and implement computational, multidisciplinary optimization for design and development of space and trans-space transportation vehicle systems.
- Develop life-cycle analyses (including cost) to support independent assessments of the early conceptual stages of projects and programs for the purpose of making informed decisions on selection as well as investment choices for the Agency.
- Develop and utilize spacecraft and space transportation vehicle preliminary design and mission design and evaluation tools for application to flight mission concepts, Agency space mission concepts, and independent assessment evaluations.
- Develop and implement planetary entry analysis tools for robotic and human space flight missions for Earth orbit and planetary systems.

## Aerodynamics, Aerothermodynamics, and Hypersonic Airbreathing Propulsion

- Develop, assess, and apply aerodynamic and component integration technologies to enable development of advanced subsonic, supersonic, and high performance aircraft.
- Manage, operate, and provide aerodynamic, aerothermodynamic, aero- and hypersonic-propulsion, and acoustic test capabilities for Agency and industry research and development of a broad class of aerospace vehicles.
- Develop, assess, and apply aerothermodynamic technologies to enable development of hypersonic aircraft, launch vehicles, and planetary and earth entry systems.
- Develop, assess, and apply hypersonic airbreathing propulsion technologies to enable development of hypersonic airbreathing vehicles.
- Develop, assess, and apply acoustic technologies in the development of advanced aerospace systems and to meet environmental requirements.

## Structures and Materials

- Develop advanced materials and processing technologies to enable the fabrication of low-cost structural concepts for high performance aerospace applications.
- Conduct research and technology development that accurately and efficiently predicts behavior, durability and damage tolerance, evaluates concepts, and validates performance of advanced materials for aerospace structures.
- Conduct research and technology development for advanced sensors, intelligent systems, and ground operational behavior to ensure structural integrity, reliability, and safety for aerospace vehicles.
- Conduct research and technology development to quantify and control aeroelastic response, unsteady aerodynamic flow phenomena, and structural dynamics behavior for flexible aerospace vehicles.

## Airborne Systems and Crew Station Design and Integration

- Design, build, integrate, and test highly reliable, digital electronic and electromagnetic systems for aerospace applications.
- Develop and demonstrate methodologies for designing and verifying high integrity digital

and electromagnetic systems in mission or life critical aerospace applications.

- Develop techniques to use microgravity environment to improve semiconductor materials.
- Develop aerospace vehicle flight dynamics design requirements, modeling methods, analysis tools, and test techniques and conduct flight dynamics evaluations of aerospace vehicle configurations.
- Develop and validate guidance and control design methods, analysis tools, and algorithms for aerospace vehicles.
- Develop requirements, concepts, and design guidelines for flight deck systems and their integration into airplane flight decks.

## Atmospheric Sciences and Remote Sensing

- Conceive, develop, and use advanced instrumentation to observe, characterize, and analyze regional and global atmospheric processes with emphasis on remote sensing from space.
- Develop advanced technologies and measurement techniques to enable new science measurements and to reduce science instrument life cycle cost.
- Develop and utilize theoretical models and analytical techniques to interpret atmospheric observations and understand global change.
- Produce, analyze, interpret, and disseminate atmospheric data sets necessary for understanding atmospheric radiative, chemical, dynamical, and meteorological processes and interpreting trends.
- Identify critical atmospheric science issues and contribute to national and international assessments of the environment, including the impact of aircraft and other anthropogenic activities on long term global changes.
- Conduct analysis, design, and hardware development of advanced materials and structures, detectors, electro-optic materials, and controls for advanced aircraft and spacecraft remote sensing systems.
- Develop advanced remote sensing technique instrumentation and integrated sensors for low-cost, high performance monitoring of Earth and planetary atmospheres.
- Develop models and perform measurements and simulation for advanced electro-optic materials and atmospheric lidar systems to predict system performance in both Earth and planetary atmospheres.
- Develop advanced diode-pumped solid-state lasers and lidar systems to meet the unique atmospheric science needs of the Earth Science and Space Science Enterprises.
- Leverage Space and Atmospheric Science remote sensing technology to develop atmospheric monitoring instruments applicable to aircraft operations performance and safety.

## Supporting Infrastructure

In support of the research core competencies, Langley has four supporting capabilities outlined below that are a strategic combination of skills, technologies, and acquired knowledge that provide services and products for efficient use of the Wind Tunnels, Laboratories, Simulators, Flight Experimental Systems, and intercenter reliances on Aircraft and Computers. These facilities and equipment are vital tools for conducting our research programs.

### Supporting Capabilities

- Develop, evaluate, integrate, and implement enabling state of the art technologies for test articles, instruments, and facilities for airframe systems, atmospheric sciences, and related space technologies research programs.

- Develop, provide, operate, and maintain research models, instruments, facilities, and systems to meet the evolving ground-based requirements of the research community.

- Develop and provide scientific and technical information services and products for assimilating, managing, and disseminating research results.

- Develop and provide institutional services and products to maintain the research support infrastructure and facilities.

# Section VI—Agency Support Activities

A broad range of personnel, facility, and operational support services is required to support NASA's ambitious mission. Just as NASA is streamlining its technical activities by establishing Centers of Excellence for technical development, so too is it consolidating many of its Agencywide support activities at specific Centers to reduce duplication of effort, enhance performance, and bring overall operational costs down. NASA Headquarters has assigned the following Agency support activities to the Langley Research Center.

## Lead for Non-Destructive Evaluation

### Goal

- Deliver significant improvements in safety, reliability, and probabilities for mission success.

**Objectives**

- Develop and maintain Agencywide NDE infrastructure, standards and specifications, relevant cost-effective NDE methodology, and instruments and transfer them to other Centers and industry.
- Strengthen cooperative NDE efforts among the Centers and Programs.
- Identify potential safety and reliability areas of concern.

### LaRC Implementation Strategy

- The NDE Program will closely coordinate, via the NASA NDE Working Group (NNWG), all interested Headquarters Offices and Centers.
- Develop and maintain a coordinated and comprehensive Agencywide NDE program.
- The NDE task execution within the NDE Program will be the responsibility of representatives at the Centers.

## Lead for Scientific and Technical Information

### Goal

Foster innovative ways for NASA to collect, organize, publish, archive, and disseminate not only the Scientific and Technical Information (STI) that it produces but also the relevant and timely information that it obtains from the scientific and technical community outside the Agency.

**Objectives**

- Establish and maintain a strategy for acquisition, preservation, and dissemination of STI products and services which is responsive to NASA mission objectives.
- Base the program on identified customer and stakeholder needs by designing and evaluating our products and services based on these needs, how the information is used, and what will be needed in the future.
- Acquire and maintain a comprehensive, relevant repository of STI.
- Capture, preserve, and disseminate 100 percent of NASA-produced STI and reduce the time required to locate, capture, and disseminate this STI.
- Ensure an equitable balance of STI exchange between NASA and NASA's exchange partners, particularly the foreign data exchange partners.
- Provide seamless electronic full-text delivery (using navigators and organizers) to the desktop by using advanced computer

systems for a wide variety of information types, formats, and media that are essential to and advance the knowledge and competitiveness of our customers.

- Radically reduce the number of divergent systems and databases that our customers must use to access information.
- Link the STI Program to other world-class information programs and foster collaborative internal and external partnerships.
- Streamline information resources and processes to remove duplication and redundancies.
- Implement mechanisms for performance measurement, feedback, and continuous improvement.
- Maintain access to STI personnel who can provide training, act as problem solvers, or provide assistance when customers need more help than can be provided via their desktops.
- Make STI products and services known and educate customers in their most-effective use.

**LaRC Implementation Strategy**

- Establish infrastructure to implement lead Center activity for the STI Program.
- Initiate a Business Process Re-engineering (BPR) Assessment of Agency STI Program and recommend changes to Headquarters and implement approved changes.
- Revise and get approval for STI Program procedures and guidelines.
- Reduce the costs of operation of, improve the efficiency for, and integrate the goals of the Center for AeroSpace Information (CASI) with the strategic goals of the STI Program.

## Lead for Program/Project Management Initiative Training

**Goal**

- Provide education and development support to intact project management teams.

**Objectives**

- Establish a protocol of services and products that can be available to all NASA project teams.
- Work with pilot project teams to provide educational and team support to enhance the effectiveness of project performance.
- Establish metrics to identify the value of intact team efforts.

**LaRC Implementation Strategy**

- Provide training and tools to intact project management teams.
- Benchmark with other organizations to learn how they assess the effectiveness of team efforts.
- Improve and assess the effectiveness of project management teams through team training and development.

# Section VII—Functional and Staff Areas

To assure that the Langley Research Center is successful in accomplishing its mission, an effective and efficient structure must be in place to carry out essential support activities. These functions will be provided with minimum resource expenditures and maximum benefits to the programs and projects charged with primary responsibility for meeting specific Agency goals and objectives. The goals, objectives, and implementation strategies for the various support functions are delineated in this section.

## Chief Counsel

### Goal

- Provide high quality legal advice and assistance; innovative, effective, and professional representation and counsel; and make valued contributions as essential members of the LaRC and NASA teams.

**Objectives**

- Greatly increase the efficiency, accuracy, and timeliness of legal services.
- Maintain and enhance the professionalism of the OCC (Office of Chief Counsel) staff.
- Maintain and further develop excellent internal and external relationships with clients, customers, and stakeholders by providing thoroughly researched legal advice.
- Practice preventative law to the maximum extent feasible.
- Assist in fulfilling the NASA and LaRC value of integrity.

**LaRC Implementation Strategy**

- Develop and manage an ethics program that will promote the observance of high ethical standards and integrity.
- Establish an OCC World Wide Web page as an effective communication tool to address legal and ethics issues in a meaningful yet friendly manner.
- Develop new and innovative legal instruments and relationships to facilitate partnering and technology transfer efforts.
- Support programmatic efforts through legal assistance and meaningful reviews of contractual instruments.
- Actively participate in the development of processes to manage technical and proprietary data.
- Anticipate legal issues through proactive contacts with Center clients.
- Develop solid understanding of Center's major programs by visiting clients, touring their facilities, and by inviting them to OCC as guest speakers.
- Present a positive, enthusiastic image to Center clients and external customers.
- Render legal advice which goes beyond concurrence or nonconcurrence by offering options, using innovative approaches, providing risk analyses, encouraging risk-taking where appropriate, and practicing "respectful irreverence" for the status quo.
- Encourage and facilitate dispute avoidance practices.
- Represent our client before adjudicatory forums and where appropriate successfully resolve disputes with Alternative Disputes Resolution (ADR), including settlement.
- Monitor client relations by developing client feedback questionnaires to help ensure that

client expectations for legal support are met or exceeded.

- Enhance and organize computer systems, including research tools (online and CD-ROM library system).

## Education Outreach Programs

### Goal

- Communicate widely within the formal and informal educational communities the content, relevancy, and excitement of NASA missions and discoveries to inspire America's students and promote excellence in education, to create learning opportunities, and to increase understanding and the broad application of science, mathematics, and technology.

**Objective**

- Develop and implement science, mathematics, engineering, and technology education programs, services, and research opportunities, consistent with the Goals 2000 Standards, that meet the needs of educators and students at all levels within the formal and informal educational institutions and effectively communicate NASA's mission to these communities.

- Using computer and information technology communicate the services and products of the Agency and Center to all customers in the educational community; inspire students, parents, teachers, faculty, and the public with NASA's missions and accomplishments; and leverage resources to reach the most appropriate audience with the best available information.

**LaRC Implementation Strategy**

- Support America's in-service and preservice teachers, faculty, and students through the use of facilities and resources to enhance knowledge and skills in science, mathematics, engineering, and technology.

- Facilitate development of instructional products based on NASA's unique mission and provide access to these products through the innovative use of technology.

- Focus teacher, faculty, parent, and student programs and products on the Strategic Enterprises and Langley Research Center Roles and Missions.

- Align all educational products with the national standards for science, mathematics, geography, and technology education.

- Use professional educators to develop and document program outcomes.

- Coordinate programs and products with state framework efforts and systemic change in science, mathematics, and technology education.

- Use a variety of information technologies, telecommunications, and Distance Learning techniques to communicate the results of NASA sponsored research and promote educational excellence.

- Evaluate processes, services, and programs annually and implement Education Computer Aided Tracking System (EDCATS).

- Develop external resource partnerships and alliances with local, state, regional, and national associations; school systems; and schools.

- Develop internal partnerships to support educational and public outreach efforts.

## Equal Opportunity

### Goal

- Create a work environment that is free of unlawful discrimination and sexual harassment, accessible to individuals with disabilities, ensures fair and equitable treatment for all employees, values workforce diversity, and fosters mutual respect in an effort to achieve the mission of the Agency and Langley.

**Objectives**

- Ensure that all policies, procedures, and processes provide all employees an equal opportunity to develop, participate, and compete fairly and equitably.
- Ensure that workforce representation in all occupations and at all levels is reflective of the nation's diversity.
- Ensure that all facilities are accessible and reasonable accommodations are provided to disabled employees.

**LaRC Implementation Strategy**

- Conduct review of all policies, procedures, and processes to ensure that equal opportunity is afforded all employees.
- Provide all employees, including managers and supervisors, a copy of Langley's Affirmative Employment Plan.
- Monitor recruitment, hiring, and advancement, where opportunities exist, to ensure the inclusion of minorities, females, and the disabled.
- Coordinate EEO (Equal Employment Opportunity) training for all employees, including managers and supervisors, to ensure awareness of laws and regulations governing unlawful workplace discrimination, affirmative employment, and accessibility for the disabled.
- Provide all employees available information on avenues of redress for workplace disputes and allegations of unlawful discrimination.
- Select and train EEO counselors reflective of the workforce by occupation, race, gender, and culture.
- Foster mutual respect through special emphasis program observances and committees, such as Federal Women's Program Committee, Satellite Committee for Persons with Disabilities, and Multicultural Leadership Team.

## External Affairs

### Goal

- Expand knowledge of and foster recognition and support for Langley Research Center, its employees, and its programs by ensuring that the value of LaRC is understood by its stakeholders: the public, strategic partners, and National decision makers.

**Objective**

- Inform stakeholders how LaRC improves American technological and economic competitiveness in the global marketplace, ensures National security, and improves the quality of life.

**LaRC Implementation Strategy**

- Coordinate the funding and implementation of the LaRC Stakeholder Value Communication Strategy, which calls for the use of all available communications tools and strategies to promote extensive communications with stakeholders.
- Update the LaRC Stakeholder Value Communication Strategy, develop new annual goals and stakeholder-value projects, and advocate for funding and support to implement this strategy.
- Promote the Stakeholder Value Communication Strategy to all LaRC organizations, managers, and employees.

## Financial Management

### Goal

- Effectively and efficiently facilitate the accomplishment of the Center's mission through innovative and flexible resources management and financial accounting in accordance with applicable laws, regulations, and policies.

**Objective**

- Develop and implement budget and accounting policies, procedures, systems, and controls. In addition, the office provides Center management with advice and information on utilization of financial resources.

**LaRC Implementation Strategy**

- Support the development and implementation of the Agency's Integrated Financial Management Program (IFMP).
- Support the development and implementation of the Agency's full cost management, budget, and accounting systems.
- Prepare audited Center and Agency financial statements.

## Human Resources

### Goal

- Ensure that LaRC has a productive, skilled, and diverse workforce to accomplish the Center's missions, programs, and projects.

**Objectives**

- Develop tactical plan to ensure that LaRC will be a model of human resource (HR) strategic leadership and proactive in achieving goals and objectives.
- Develop processes that are efficient and effective and lead to high quality, innovative, creative products and services.
- Increase automation for managerial processes and increase availability of desktop HR data to managers.
- Develop an HR team to continuously improve professionalism, productivity, and cross-functional skills.
- Maintain internal and external HR partnerships characterized by mutual support and cooperation to deliver quality and timely products and services.

**LaRC Implementation Strategy**

- Reorganize the Office of HR to improve customer support for accomplishing the Center's roles and mission assignments.
- Provide excellent personnel systems and services which enable the organizations to deploy human resources effectively while accomplishing the Center's goals.
- Develop a Strategic Training Framework that will reengineer the assessment process for identifying and prioritizing the Center's developmental requirements.
- Identify and provide essential tools, training, and development necessary to address the present skills imbalance of the staff.
- Design and implement interventions to meet the organizational reengineering requirements of the Center.
- Implement Employee Development Plans which are focused on the Center's strategic needs.
- Support the Agency initiative to replace the HR legacy automated systems with a fully integrated commercial-off- the-shelf (COTS) application.
- Provide occupational health and quality of work life services to assure that employees can perform their duties in the best of health, well-being, and productivity.

## Information Technology—Policy and Oversight

### Goal

- The LaRC Office of the Chief Information Officer (CIO) ensures that the Center's acquisition, management, and deployment of information technology (IT) resources is well planned and demonstrates an efficient return on investment that is consistent with the Clinger-Cohen Act of 1996.

**Objectives**

- Provide leadership and strategy for the implementation of Agencywide initiatives such as Year 2000 and Outsourcing the Desktop Initiative for NASA (ODIN), that are pursued for IT cost effectiveness, infusing new technologies, increasing productivity, and managing the Agency's IT investment.

- Prepare the Center for implementation of ODIN. ODIN, an initiative to outsource desktop computing and communications across the Agency, is being pursued to meet current and future IT needs in the substantially reduced budget environment. The outsourcing contractor will perform routine IT functions, thus allowing NASA to focus on its core competencies and capabilities.

- Develop the Year 2000 strategy for LaRC. Provide leadership, coordination, and consultation to all LaRC organizations in validating Year 2000 risk assessments.

- Provide a focus for Centerwide IT planning, architectures, and standards consistent with established Enterprise, Agency, and Federal policies, goals, and standards.

- Support the LaRC Chief Financial Officer in assessing and integrating IT readiness issues into Integrated Financial Management Program (IFMP) implementation planning.

### LaRC Implementation Strategy

- Establish an ODIN Implementation Team at LaRC to coordinate all activities associated with the successful outsourcing of desktop computers.

- Provide expertise to assist LaRC organizations in developing strategies to address potential Year 2000 issues.

- Work with the Agency CIO community in setting the appropriate IT standards and policies. Communicate those standards and policies to the Center to assist organizations in effectively managing IT resources.

- Conduct quarterly meetings of the LaRC CIO Advisory Committee to ensure all LaRC organizations are aware of and involved in CIO activities.

- Establish and implement processes and tools to facilitate the availability of information about LaRC IT assets.

## Internal Operations

### Goal

- Provide critical technical and administrative capabilities which enable and enhance Center programs and operations in the most efficient manner possible to ensure the success of Center roles and missions.

**Objectives**

- Provide an effective information systems network of computer and communications resources.

- Provide highly capable engineering and technical services in support of Langley facilities and programs.

- Provide productive, cost-effective, and safe test services in support of LaRC's roles and missions.

- Provide essential logistics and administrative support to facilitate accomplishment of the Center's mission.
- Maintain an effective labor and management partnership.

**LaRC Implementation Strategy**

- Implement organization-centered product line processes for providing engineering, test, and information services.
- Implement a Wind Tunnel Reengineering Program to substantially increase productivity, reduce cost, and improve customer satisfaction.
- Implement facility closure initiatives to support planned efficiencies and budgets.
- Plan investments with internal customers, which uses product line approach to maximize outcomes.
- Implement Project Reliance recommendations in cooperation with other Code R Centers.

## International Standards Organization 9000

### Goal

- To align the management system with best commercial practices, all Centers and NASA Headquarters will become International Standards Organization (ISO) 9001 certified by a third party by September, 1999.
- To achieve certification, the organization shall establish, document, implement, and maintain a system that will provide confidence to both the management and the customer that the intended quality of products and services will be, is being, and has been achieved and that will ensure that the products and services supplied conform to customer requirements.

**Objectives**

- Contribute directly to our goals as embodied in Langley's Strategic and Quality Framework.
- Improve our critical success factors in all three areas: customer value, stakeholder value, and organizational value.
- Directly improve the quality of our products and services.
- Determine the applicability of the standard to our business and provide validation of applicability to third party assessors.
- Design and implement an efficient, effective, and value-added ISO 9001 program that capitalizes on existing reengineering and reinvention efforts.

**LaRC Implementation Strategy**

- Project Office has been established to lead the Center's implementation of ISO 9001 standards.
- This Office reports to the Associate Director of Langley who serves as the ISO management representative and sponsor of the project.
- The Project Office will exist for the time period through certification, approximately 2 years.

## Procurement

### Goal

- As a customer-based organization, become a valuable contributor on the LaRC team by acquiring goods and services, which meet or exceed our customers' expectations.

**Objective**

- Emphasize early planning that considers all potential acquisition strategies and ensure that all the goods and services that are acquired through simplified acquisitions, contracts, grants, cooperative agreements, Economy Act purchases, and NASA Research Announcements, are compliant with Federal and NASA regulations and consistent with good business practices.

**LaRC Implementation Strategy**

- Expand the use of big range procurement procedures in acquisitions up to $50 million.
- Fully implement electronic commerce in all areas of the acquisition cycle, including the ability for users to obtain equipment and services through direct online ordering.
- Fully automate the proposal evaluation process.
- Expand the use of oral proposals on competitive procurement actions.
- Simplify the evaluation process by eliminating unnecessary steps and adopting appropriate commercial practices and processes.
- Expand use of performance-based contracts, emphasizing work statements, specifications, and delivery schedules.
- Expand the use of cooperative agreements to execute programs by gaining the value from a partnership between Government and industry.
- Use Agencywide consolidated contracts for equipment and services common to most Centers to realize significant savings through economies of scale and to significantly reduce the time required for obtaining equipment and services.
- Simplify and automate the bankcard reconciliation for the technical and finance community.
- Continue to pursue outsourcing opportunities in accordance with Workforce 2000 goals.
- Facilitate advocacy with our customers, including legal and technical, to promote teamwork for reducing lead-times and improving the quality of the procurements.

## Safety and Mission Assurance, Environmental Programs, and Security

**Goals**

- Safety—Full regulatory compliance with Occupational Safety and Health Act (OSHA). Reduce civil servant lost time occupational injuries. Reduce property loss due to fires or inclement weather. Reduce property loss due to improper facility design or operation.
- Mission assurance—Achievement of mission success criteria for all spaceflight projects. No damage to aircraft or research equipment on flight research projects. Reduce property loss due to research model failure. Maximize customer satisfaction for supported aeronautics research and technology products.
- Environmental Programs support—Initiate environmental restoration; full compliance with environmental regulations. No hazardous waste generation. Double the amount of materials recycled from 1997 levels. Increase procurement of paper, tires, concrete, insulation materials, and lubrication oil with recycled content.
- Security—Reduce property losses associated with theft or acts of violence. No personnel injury case resulting from acts of violence or traffic incidents. Minimize security incidents that could lead to loss of classified information.

**Objectives**

- Assure the safety, reliability, quality, and environmental compatibility of the Center's space and aeronautics research and technology products, regardless of whether the products are developed by the Center, contractors, or educational institutions.

- Assure the security, reliability, maintainability, safety, and environmental compatibility of the Center's facilities and the security and safety of the Center's operations and functions.

**LaRC Implementation Strategy**

- Develop safe and reliable technologies with a pedigree of development, analysis, and tests for ultimate transfer to industry.
- Ensure that wind tunnel and drop models perform as intended and provide the necessary information to research personnel.
- Ensure, in concert with the Center's acquisition function, that contractors and subcontractors deliver products and services which comply with LaRC requirements.

## Technology Transfer

### Goal

- Develop and implement innovative technology transfer practices characterized as exemplary that bring significant return on investments to our stakeholders, our customers, and NASA and LaRC missions.

**Objectives**

- Create optimized partnerships for LaRC's investment in the commercialization program with emphasis on licensing our intellectual property to create wealth, quality jobs, and quality of life opportunities benefiting U.S. taxpayers while advancing our aerospace mission potential.
- Optimize return to Stakeholders through increased visibility of technology transfer successes.

**LaRC Implementation Strategy**

- Dramatically increase the value of partnerships in commercialization through strategic licenses and partnerships with companies, consortia, and other government agencies.
- Explore traditional and nontraditional activities for technology transfer with small and large businesses recognizing the limits on LaRC's resources and the opportunities of expanded programs through external partnerships.
- Use LaRC Small Business Innovative Research Program (SBIR) to create funded opportunities for industry that will positively impact the Center's effectiveness and will increase the percent of SBIR commercial successes.
- Ensure that return on investment metrics such as royalties to the Center, augmented workforce from partnerships, and accelerated maturation of technology will increase.
- Measure all activities as to their impact on LaRC's Strategic and Quality Framework (SQF) metrics for customers, organization, and stakeholders.
- Expand the use of Memorandum of Agreement (MOA) and Patent License Congressional Announcements, NASA TechTracS Success stories on the World Wide Web, and NASA Tech Briefs to highlight technology transfer successes.

# Abbreviations and Acronyms

**ARC**
Ames Research Center

**ASHOE/MAESA**
Airborne Southern Hemisphere Ozone Experiment/Measurements for Assessing the Effects of Stratospheric Aircraft

**ASPO**
Airframe Systems Program Office

**AST**
Advanced Subsonic Technology

**ASTT**
Aeronautics and Space Transportation Technology

**ATTO**
Aerospace Transportation Technology Office

**CERES**
Clouds and the Earth Radiant Energy System

**DAAC**
Distributed Active Archive Center

**DARPA**
Defense Advanced Research Projects Agency

**DFRC**
Dryden Flight Research Center

**DIAL**
Differential Absorption Lidar

**DoD**
Department of Defense

**EOS**
Earth Observing System

**ES**
Earth Science

**FAA**
Federal Aviation Administration

**FIRE**
First ISCCP (International Satellite Cloud Climatology Project) Regional Experiment

**GAS**
Geostationary Atmospheric Sounder

**GSFC**
Goddard Space Flight Center

**GTE**
Global Tropospheric Experiment

**HALOE**
Halogen Occultation Experiment

**HEDS**
Human Exploration and Development of Space

**HR**
Human Resources

**HSCT**
High-Speed Civil Transport

**HSR**
High Speed Research

**IMPACT**
Interactive Modeling Project for Atmospheric Chemistry and Transport

**ISAMS**
Improved Stratospheric and Mesospheric Sounder

**ISS**
International Space Station

**LaRC**
Langley Research Center

**LASE**
Lidar Atmospheric Sensing Experiment

**LeRC**
Lewis Research Center

**LITE**
Lidar In-space Technology Experiment

**MSFC**
Marshall Space Flight Center

**NASA**
National Aeronautics and Space Administration

**NAST**
NPOESS Airborne Sounder Testbed

**NDE**
Non-Destructive Evaluation

**NDSC**
Network for the Detection of Stratospheric Change

**NOx**
Nitrogen oxide

**NPOESS**
National Polar Orbiting Environmental Satellite System

**POLARIS**
Photochemistry of Ozone Loss in the Arctic Region in Summer

**RLV**
Reusable Launch Vehicle

**RTG**
Research Technology Group

**SAGE**
Stratospheric Aerosol and Gas Experiment

**SQF**
Strategic and Quality Framework

**SRB**
Surface Radiation Budget

**SS**
Space Science

**STI**
Scientific and Technical Information

**STRAT**
Stratospheric Tracers of Atmospheric Transport

**TRMM**
Tropical Rainfall Measuring Mission

**TRP**
Technology Reinvestment Project

**UAV**
Uncrewed Aerodynamic Vehicle

**USMP**
United States Microgravity Payload

# Points of Contact

For further information regarding the Langley Implementation Plan, please contact the following individuals.

## Agency Lead Activities

| | | |
|---|---|---|
| Center of Excellence for Structures and Materials | C. E. Harris | 757-864-3492 |
| Lead Center for Independent Program Assessment | W. M. Piland | 757-864-4800 |

## Aeronautical and Space Transportation Technology, ASTT

| | | |
|---|---|---|
| Lead Center for Airframe Systems Research and Technology | D. R. Tenney | 757-864-6033 |
| Lead Center for Advanced Subsonic Technology | S. A. Morello | 757-864-6515 |
| Lead Center for High Speed Research | W. C. Sawyer | 757-864-2267 |
| Lead Center for Aviation Safety Research | M. S. Lewis | 757-864-9100 |
| Facility Group Lead for Wind Tunnels and Aerothermodynamic and Aeropropulsion Facilities | B. B. Gloss | 757-864-5113 |
| Earth Orbit and Hypersonic Transportation Technology | D. C. Freeman | 757-864-2836 |

## Earth Science, ES

| | | |
|---|---|---|
| Atmospheric Sciences | W. L. Smith (ASD) | 757-864-5380 |
| EOSDIS Distributed Active Archive Center | Vacant | 757-864-6589 |
| Sensors and Instrument Technology | W. T. Lundy | 757-864-4451 |
| U.S./Russia Meteor III/SAGE III Mission | L. E. Mauldin | 757-864-5382 |
| Clouds and Earth's Radiant Energy Instrument | J. E. Cooper | 757-864-5672 |
| Field Missions (GTE and FIRE) | J. M. Hoell | 757-864-5826 |

## Space Science, SS

| | | |
|---|---|---|
| Explorer and Discovery Programs | M. P. Saunders | 757-864-9850 |
| Spacecraft Cross-Cutting Technology | W. T. Lundy | 757-864-4451 |
| SABER/TIMED Project | J. B. Miller | 757-864-7101 |
| Planetary Entry Analysis | R. D. Braun | 757-864-4507 |

## Human Exploration and Development of Space, HEDS

| | | |
|---|---|---|
| Technology and Vehicle/Spacecraft Systems Analyses | W. L. Smith (SASPG) | 757-864-6055 |
| Radiation Protection | J. W. Wilson | 757-864-1414 |
| Atmospheric Entry (Earth Orbit) | D. C. Freeman | 757-864-2836 |
| Planetary Entry (Non-Earth) | R. D. Braun | 757-864-4507 |

## Core Competencies

| | | |
|---|---|---|
| Mission and Systems Analysis, Integration, and Assessment (Aeronautics) | Vacant | 757-864-6399 |
| Mission and Systems Analysis, Integration, and Assessment (Space) | W. L. Smith (SASPG) | 757-864-6055 |
| Mission and Systems Analysis, Integration, and Assessment (Earth Orbit and Hypersonic Transportation) | D. C. Freeman | 757-864-2836 |
| Research and Technology Group | D. L. Dwoyer | 757-864-8983 |
| Aerodynamics, Aerothermodynamics, & Hypersonic Propulsion (Fluid Mechanics & Acoustics) | A. Kumar<br>(D. G. Stephens) | 757-864-3520<br>757-864-3640 |
| Structures | W. Whitlow | 757-864-2934 |
| Materials | M. J. Shuart | 757-864-3492 |
| Airborne Systems | H. M. Holt | 757-864-1596 |
| Crew Station Design & Integration | L. T. Nguyen | 757-864-1718 |
| Atmospheric Science | W. L. Smith (ASD) | 757-864-5380 |
| Remote Sensing | L. R. McMaster | 757-864-1733 |
| Supporting Infrastructure | S. D. Joplin | 757-864-6014 |

## Agency Support Activities

| | | |
|---|---|---|
| Lead for Non-Destructive Evaluation (NDE) (Office of Safety & Mission Assurance) | E. R. Generazio | 757-864-4970 |
| Lead Center for Scientific & Technical Information | G. J. Roncaglia | 757-864-2374 |
| Lead Center for Program/Project Management Training | A. J. Maturo | 757-864-2590 |

## Functional and Staff Areas

| | | |
|---|---|---|
| Chief Counsel | K. A. Kurke | 757-864-3221 |
| Chief Information Officer | P. L. Dunnington | 757-864-6627 |
| Education Outreach Programs | S. E. Massenberg | 757-864-5800 |
| Equal Opportunity | V. B. Merritt | 757-864-3290 |
| External Affairs | A. G. Price | 757-864-6124 |
| Financial Management | J. R. Struhar | 757-864-8084 |
| Human Resources | A. C. Massey | 757-864-2554 |
| Internal Operations | S. D. Joplin | 757-864-6014 |
| ISO-9000 Implementation | F. S. Collier, Jr. | 757-864-1919 |
| Procurement | W. R. Kivett | 757-864-2426 |
| Safety and Mission Assurance, Environmental Programs, Security | H. T. Garrido | 757-864-3361 |
| Technology Transfer | J. S. Heyman | 757-864-6005 |

## General Information

| | | |
|---|---|---|
| General Information Concerning Text | I. J. Schauer | 757-864-2552 |

**The Langley Research Center World Wide Web page is available at the following address:**

**http://www.larc.nasa.gov/**

# Appendix A—Programs, Projects, and Activities of Langley Research Center

## Aeronautics and Space Transportation Technology Enterprise (ASTT)

- Research and Technology Base
  - Information Systems
  - Airframe Systems (Lead Center)
  - Propulsion Systems
  - Flight Research
  - Aviation Operations Systems (AOS)
  - Rotorcraft
- High Performance Computing and Communications (HPCC)
- High Speed Research HSR (Lead Center)
- Advanced Subsonic Technology (AST) (Lead Center)
- Aviation Safety (Lead Center)
- Space Transportation
  - Reusable Launch Vehicles (RLV)
  - Advanced Space Transportation Program
- Commercial Technology
- Small Business Innovative Research (SBIR)
- Small Business Technology Transfer (STTR)

## Earth Science Enterprise (ES)

- Research and Analysis
- Sensors and Detectors Technology Development
- Gas and Aerosol Sensorcraft (GAMS)
- Cloud's and the Earth's Radiant Energy System (CERES) Instrument
- Cloud's and the Earth's Radiant Energy System (CERES) Algorithm Development
- Stratospheric Aerosol and Gas Experiment (SAGE) III Instrument
- Stratospheric Aerosol and Gas Experiment (SAGE) III Algorithm Development
- Stratospheric Aerosol and Gas Experiment (SAGE) III Mission Operations
- Earth Observing System Distributed Active Archive Center (EOSDIS DAAC)
- Space Radiation Budget (SRB) Data Analysis
- Measurement of Air Pollution from Satellite (MAPS)
- Lidar Atmospheric Sensing Experiment (LASE)
- Upper Atmospheric Research Satellite (UARS)
- Halogen Occultation Experiment (HALOE)
- Improved Stratospheric and Mesospheric Sounder (ISAMS)
- Earth Radiation Budget Experiment (ERBE)
- Earth Science
- Stratospheric Aerosol and Gas Experiment (SAGE) II Mission Operations and Data Analysis

## Space Science Enterprise (SS)

- Independent Assessments
  - Gravity Probe-B
  - Advanced X-Ray Astrophysics Facility
- Explorer Advanced Studies

- Discovery Advanced Planning
- Research and Analysis
- Solar, Anomalous, and Magnetospheric Particle Explorer (SAMPEX)
- Thermosphere, Ionosphere, Mesophere Energy and Dynamics (TIMED) Development
- Spacecraft Technology
- Planetary Entry
- New Millennium Advanced Concepts
- Mars Surveyor Technology Development and Mission Studies
- Astrophysics Research Associates

## Human Exploration and Development of Space Enterprise (HEDS)

- Space Radiation Effects and Protection
- Microgravity Research and Analysis
- Microgravity Flight Projects
- Space Projects Development
- Radiation Protection
- Stratospheric Aerosol and Gas Experiment (SAGE) III Instrument
- Flight Hardware
- Test, Manufacturing, and Assembly
- Flight Technology Demo
- Advanced Projects
- Safety and Performance Upgrade

# Appendix B—Contributions of Langley Research Center to the Strategic Enterprises

| LaRC Assignments and Activities | ASTT | ES | SS | HEDS |
|---|---|---|---|---|
| **Primary Mission Assignments** | | | | |
| • Airframe Systems | • | | | |
| • Atmospheric Science | | • | | |
| **Center of Excellence Assignment** | | | | |
| • Structure and Materials | • | • | • | • |
| **Lead Program Assignments** | | | | |
| • Advanced Subsonic Technology | • | | | |
| • High Speed Research | • | | | |
| • Airframe Systems Research and Technology | • | | | |
| • Aviation Safety Research | • | | | |
| **Agency Functional Assignments** | | | | |
| • Independent Program Assessment | • | • | • | • |
| • RLV Systems Analysis Support | • | | | • |
| • Space Science Enterprise Implementation Support | | | • | |
| • Wind Tunnel Facility Group | • | | | |
| **Core Competencies** | | | | |
| • Mission and Systems Analysis, Integrations, and Assessment | • | • | • | • |
| • Aerodynamics, Aerothermodynamics, and Hypersonic Airbreathing Propulsion | • | | • | • |
| • Airborne Systems and Crew Station Design and Integration | • | | | |
| • Structures and Materials | • | • | • | • |
| • Atmospheric Sciences and Remote Sensing | • | • | • | • |
| • Supporting Infrastructure | • | • | • | • |
| **Agency Support Activities** | | | | |
| • Non-Destructive Evaluation | • | • | • | • |
| • Scientific and Technology Information | • | • | • | • |
| • Program/Project Management | • | • | • | • |

| LaRC Assignments and Activities | ASTT | ES | SS | HEDS |
|---|---|---|---|---|
| **LaRC Functional and Staff Areas** | | | | |
| • Chief Counsel | • | • | • | • |
| • Education Programs | • | • | • | • |
| • Equal Opportunity | • | • | • | • |
| • External Affairs | • | • | • | • |
| • Financial Management | • | • | • | • |
| • Human Resources | • | • | • | • |
| • Information Systems and Technology | • | • | • | • |
| • Internal Operations | • | • | • | • |
| • ISO 9000 Implementations | • | • | • | • |
| • Procurement | • | • | • | • |
| • Public Affairs | • | • | • | • |
| • Safety and Mission Assurance, Environmental Programs, Security | • | • | • | • |
| • Technology Transfer | • | • | • | • |

The writing team for the 1998 NASA Langley Research Center Implementation Plan included Belinda Adams (sponsor), Pete Covell, Sally Lindberg, Anne Rocky, Irwin Schauer (leader), Susan Voigt, and Scott Wagner.